MACHINERY

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GOLD AND SILVER SPINNING*

By CHESTER L. LUCAS†

THE spinning of metals is popularly supposed to be an out-of-date method of forming sheet metal; at least it is considered to be a decadent art. It is true that spinning is a much slower method of production than press work, but there are many special cases and classes of work in which spinning is the more economical method to employ, everything considered. Especially is this true in the manufacture of sterling silverware of the highest class, such as is the product of the Gorham Mfg. Co., of Providence, R. I.

Through the courtesy of Mr. Fred C. Lawton, superintendent, and Mr. Whipp, assistant superintendent of this company, the writer was allowed to photograph and record some of the interesting features of a model gold and silver spinning department and some of the machinery of the press and die departments. The main factory buildings are shown in Fig. 1, and even in the general appearance of the grounds and buildings there crops out that artistic touch that characterizes the entire product of the Gorham Co. The work of this company includes everything from the making of a sterling teaspoon to the casting of a life-size equestrian statue.

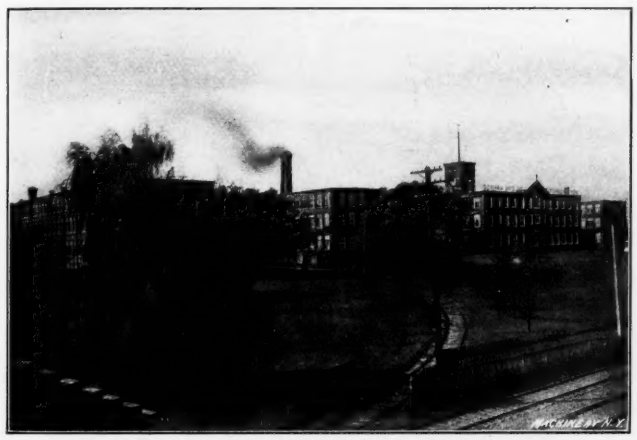

Fig. 1. Factory of the Gorham Mfg. Co., Providence, R. I.

Fig. 2. General View of the Spinning Department

Fig. 3. Some Representative Work of the Spinning Department

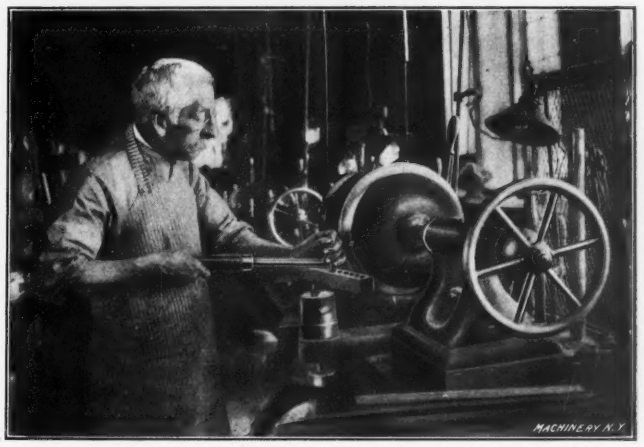

Fig. 4. A Spinner of Fifty Years' Service finishing a Silver Waiter

The Spinning Department

The gold and silver spinning department is located in a well-lighted building, as the illustration Fig. 2 shows. This department, giving employment to from 50 to 75 men, is in charge of Mr. E. W. Crocker. Fig. 3 shows a few specimens of the work produced by this department. Fully half of the work is the finishing up of shells after they have been partially drawn up in a drawing press, and includes smoothing out the wrinkles, trimming the edges, rolling beads and making accurate fits. A good idea of this class of finishing may be had from the illustration Fig. 3, which shows some of the every-day work of the department. In the rear are a number of water pitchers that have been fitted with silver tops; in the tray at the center are twenty candlestick bases that have been spun, and the square tray in the foreground is a piece of spun and pierced work that has been beaded at the edges and formed into a square shape as shown. The other articles are similar in character.

At the office of this department there is an interesting system in vogue for keeping the job records. Index cards are kept with the number of each job, the dates received and completed, the number of pieces, the weight per piece, the time consumed and a list of the operations necessary. On the reverse side of the card is pasted a photograph of the finished article—the most important feature of the record. No piecework is done in this factory, for the quality of the work performed is considered to be of far more importance than the quantity.

Spinning a Silver Waiter

The work of spinning sterling silver does not differ materially from the spinning of brass and aluminum, except that the work is of a higher grade and more care must be taken to prevent spoiling the stock. As with other classes of spinning, the point and ball tool is the one most often used. Common brown soap is used for a lubricant.

Fig. 4 shows a spinner putting the finishing touches on a silver waiter. This particular spinner is over seventy years of age and has been in the employ of the company for fifty years; in this same department there is another spinner

* For information previously published on metal spinning, see "Metal Spinning" 1 and 2 in the March and April, 1910, issues of MACHINERY, engineering edition, and accompanying reference.

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who has worked for forty-eight years. With such records of service, it is obvious that relations must be pleasant between employer and employe.

Oval Spinning

One of the most interesting spinning operations in the Gorham factory, and a branch of spinning that is followed in but few shops, is oval, or more properly speaking elliptical, spinning. In Fig. 5, the spinning lathe is shown set up with an oval chuck for medallion frames, and the spinner has just made some changes in the form before starting the spinning. As this illustration shows, the chuck is provided with a threaded spindle upon which different sizes and snapes of ovals may be mounted. It is obvious that the chuck is an important feature of oval spinning, and as its operation is somewhat novel, it may be interesting to consider the construction and working principles of one of the latest models of elliptic (or oval) chucks.

This chuck is called a "self-balancing" elliptic chuck and is made by the P. Pryibil Co., New York; it is so balanced that it may be run at a much higher speed than the ordinary oval chuck. Essentially it consists of a circular frame casting, in

Fig. 5. The Oval Chuck and a Form for Flanging Ovals

which are fitted two diametrically opposed slides. These slides are geared to a central idler gear in such a manner that they reciprocate in opposite directions in unison. The amount of travel given these slides may be regulated at will by means of a hand crank that, with the aid of a scale and indicator, may be set to turn ovals of any proportion, for the amount of travel in the slides governs the shape of the oval.

Upon one of these two slides the work-holding spindle is mounted, while the function of the other slide is to balance the movements of the work slide. Thus the chuck is self-balancing, for as one slide leaves the center to make the

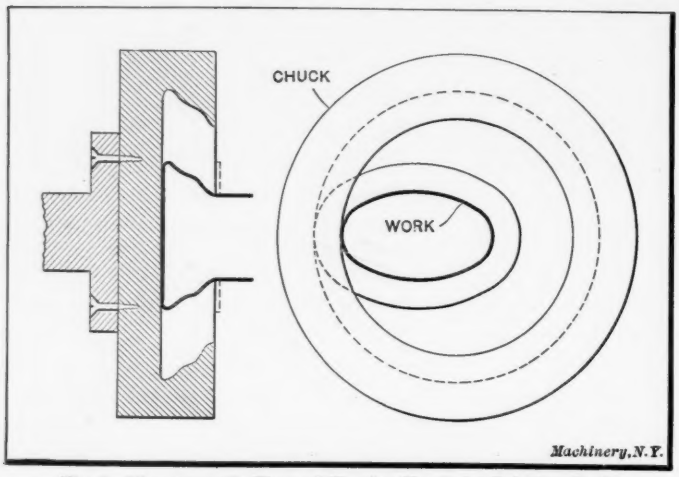

Fig. 6. Diagrammatic View of Circular Chuck for Spinning Ovals

ellipse, the opposite slide travels the same distance from the other side of the center.

With such a chuck, ovals or ellipses may be turned or spun of any size and of any proportion from a straight line to a perfect circle. The proportions of the ellipse may be varied at will without stopping the lathe, by means of the adjusting crank. The principal points of superiority that this design of chuck has over other elliptic chucks lie in the fact that there are two slides whose opposite movements balance each other, and in the fact that the proportions of the oval being turned or spinned may be changed without stopping the lathe.

Flanging Ovals in a Circular Form

A little kink in oval spinning that is of interest is the method used in flanging the oval frames shown on the lathe

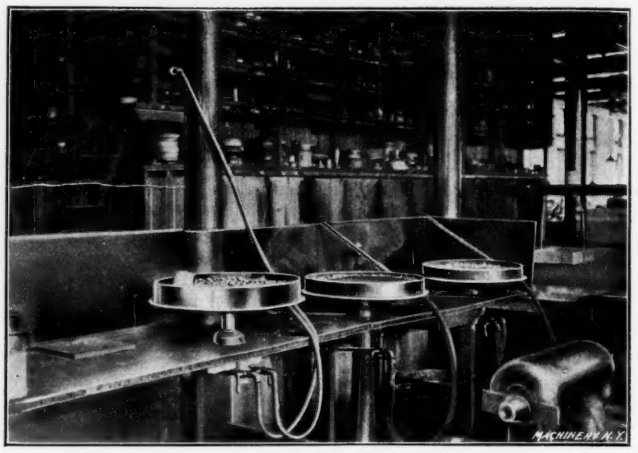

Fig. 7. The Annealing Bench and Collection of Forms

in Fig. 5, and diagrammatically in Fig. 6. The frames are first spun up, leaving the flanged part out straight. Next, a wooden form is mounted on the spindle; this form is turned out a little larger than the greatest diameter of the oval and so recessed that the frame sets within the form except for the edge that is to be flanged. The form is shown beyond the pile of frames on the lathe. The lathe is then started and with the aid of the spinning tools, the flange is turned over against the form. The surprising part of the operation is

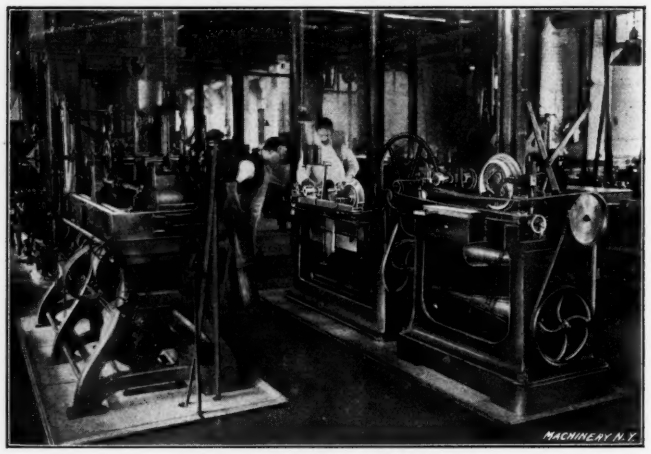

Fig. 8. Sinking Dies by Machinery

that an oval shell is flanged in a circular form, but it is more readily understood when it is explained that the pressure of the spinning tool causes the shell to bear against the form at the point where the spinning tool is held. This method gives a good flange without the use of a sectional chuck, and it should be applicable to similar flanging on ovals and circular shells in other lines of manufacturing.

Annealing Bench—Forms—Vault

Annealing is an important operation connected with spinning, and unless the half completed shells are properly annealed, there is danger from seams and cracks that may develop. In order to properly and conveniently anneal the silver shells, the spinning department is equipped with an annealing bench consisting of three turntables, filled with pumice, as shown in Fig. 7. The shells are placed on the turntables and slowly turned while the torch is directed upon the work. Thus, all parts of the work are easily reached by the flame and a good even anneal is readily obtained. The torches are fed by gas and air piped from beneath the bench. Close at hand are the pickle baths and potash tanks for removing scale and cleaning.

Above the annealing bench in this illustration may be seen the storage racks where the spinning forms are kept. In nearly every case there is the prospect of a duplicate order so that this collection represents the work of many years. Each night, shortly before closing time, the silver and gold work in process of completion is stored in a fire-proof vault, as a precaution against both fire and theft. In this vault the stock from which the product is spun is also kept.

The Spinning of Gold

Gold is a difficult metal to spin; in fact, there are few metals that resist the spinner's tool as strenuously. Unlike

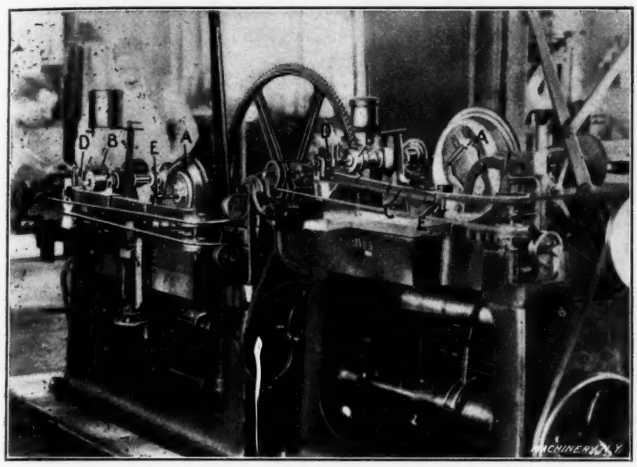

Fig. 9. Salient Features of the Janvier Engraving Machine

zinc, which is more easily spun than drawn in dies, gold is much more easily worked in dies than by spinning. For this reason it is always best to rough gold down by presswork or by swaging when possible and after the approximate shape has been reached, place the shell on an iron form and bring it to the exact size and shape required, by spinning. Iron forms are always used in spinning gold. The metal of which the shells are made is usually very thin and the pressure required is very heavy, making necessary an unyielding surface upon which to spin the gold.

The formation of grooves, ridges and other similar shapes in the work is best accomplished by "roller spinning." Roller spinning is very similar to knurling in operation, except that the rollers are plain faced, shaped to fit the forms being used. The reason for this roller spinning lies in the fact that the gold is more easily shaped this way than with a stationary spinning tool. In spinning gold, the lubricant used is a cheap grade of animal fat known as "horse grease." The rolls for spinning gold are kept on pegs in a cabinet, and when a particular roll is needed by one of the spinners, he hangs his check on the peg until the roll is returned, so that it will be easy to locate it should it be needed while in his possession. Great care is taken to prevent the loss of any of the gold while in the spinning department. At such times as they are not being worked upon, the gold shells are kept in a locked case under the care of the assistant foreman, and of course the weights of the rough stock and of the finished articles and scrap are carefully checked.

The Die-sinking Machines

Another interesting part of the Gorham Mfg. Co.'s factory is the die-sinking department. In this room are located four automatic machines for cutting the embossing dies used in the press department for striking up flat and hollow ware as well as other silver articles that require embossing. In the illustration Fig. 8 the two machines at the right are of the Janvier make; the one in the left foreground is an American machine made by the Keller people; and the machine in the background is a Janvier, but larger than the other two.

Of these machines, the Janviers are the better, both in their construction and in the quality of the work turned out. It is the opinion of the writer that if the workmanship put on the American machine was as good as on the Janvier machine, the result would excel either of the present machines, for the principles of the Keller machine are good.

Owing to the location of the large Janvier machine, it was impossible to get a close-range photograph. Only two of these machines have ever been built, as there are so few concerns making large dies in sufficient quantities to warrant the installation of such a machine. The other machine of this type is in Germany. The one here is used principally for dies for embossing large silver platters and hollow ware and it is designed so that it will reproduce the same size as the master pattern if necessary; it is impossible to do this on the other machines. In addition to these machines, there are about 30 men in this department finishing up the dies after they leave the machines. These die-sinkers also cut many dies entirely by hand.

From the illustration Fig. 9 a good idea may be had of the principles upon which the Janvier die-sinking machine operates. Briefly, the operation of the machine is as follows: A brass pattern of the design is made, enlarged several times, and is attached to the copy-holding table *A*, while in the chuck on the work-holding table *B*, the die is held. These two tables turn at the same speed, which gradually increases and decreases according to the position of the cutter in relation to the center. Lever *C* is pivoted at its left-hand end and carries the cutter *D* and the style or tracer, *E*. Tracer *E* rides upon the pattern and as it is moved in and out by the irregularities of the design, it transmits the motion to the cutter *D* that is mounted on the same lever *C*. This movement is transmitted in a lesser degree, however, as the position of the cutter is nearer the fulcrum of the lever *C*. The lever *C* also has a lateral motion parallel with the faces of the die and pattern. The die and pattern revolve in unison and, actuated by the cone pulleys beneath the machine, move more rapidly as the cutter and tracer approach the centers of the die and pattern, respectively. Thus, as the tracer moves slowly in and out of the various parts of the design, it guides the revolving cutter over the die in precisely the same proportion, slowly cutting out the steel as it does so. It takes from 6 to 20 hours to cut a die, varying with the intricacy of the design and the size and depth of the die.

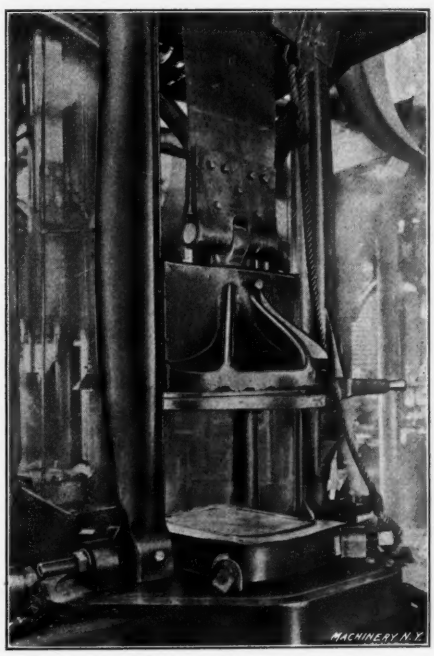

Fig. 10. Striking-up Silver Waiters under a 2000-pound Drop-hammer

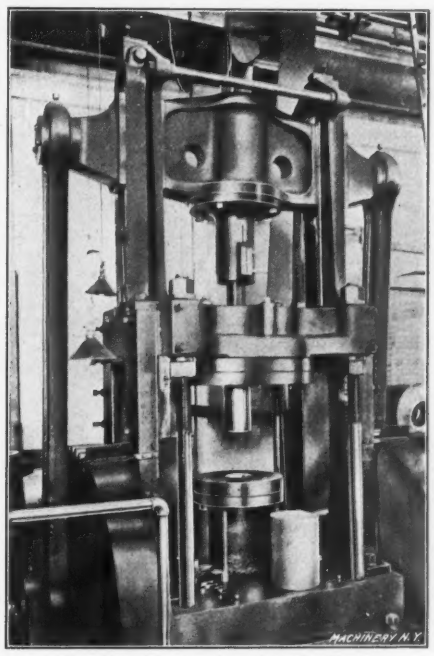

Fig. 11. The "Jumbo" Drawing Press built Fifty Years ago

Striking Up Large Silverware

The large drop press shown in Fig. 10 is for striking up large articles of silver, such as waiters, platters and similar

tableware. This press, which was built in the shops of the Gorham Co., is very heavy and of a size that is seldom met with except in drop-forging plants. The weight of the hammer is 2000 pounds, and it is raised by a roller lift which requires two men to handle. The total weight of the press is ten tons. On account of its weight, the foundation for this press was made by excavating to the depth of ten feet and placing therein three large blocks of granite. These blocks, three feet square and three feet thick, were placed one above the other and a thick layer of cement beneath the three and around the sides. This foundation has withstood the test of time well.

The dies for plain waiters are made from cast iron and the forces, or male dies, are cast of tin. Of course a cast-iron die would not do for embossing designs, but for shaping up a plain silver waiter it answers very well. The tin forces are made by lowering the hammer to within a few inches of the die and after building a wall around the die and hammer, pouring molten tin into the intervening space. In getting out a dozen waiters, the force has to be renewed once.

In striking up a lot of waiters, the die is set up and the force made as described. Within the die are placed two brass sheets, 1/16-inch thick, that lie closely over the die, following every detail of its shape. These pieces are used for "breaking down" the silver. With both of these pieces in the die, all of the blank sheets of silver are struck, this operation forming the blanks to somewhere near the shape of the die. Next, the upper of these sheets is taken out and the half-formed pieces run through again. Finally, the lower sheet is removed and the silver pieces are struck directly into the die, which operation sharpens up the form and finishes the striking operations on the waiters.

The "Jumbo" Drawing Press

In an old-established shop like the Gorham Co.'s there are a great many sidelights on mechanical history; the drawing press shown in Fig. 11 affords one good example. This press, known throughout the factory as the "Jumbo" press, was made in the days "before the war," and it is in use at the present time; one of the shells made in it is shown standing on the bed. This shell is of silver, ten inches diameter and fourteen inches deep, and was drawn up in seven operations. The press will take blanks up to 30 inches in diameter. Crankshafts at either side of the press actuate the ram, being connected with geared driving wheels that extend beneath the flooring. This press is not to be compared with the modern metal-working machinery of to-day, being neither powerful nor quick, but it is interesting in that it illustrates the work of the machine designers and builders of fifty years ago.

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LARD OIL AS A CUTTING LUBRICANT

There is a difference of opinion as to the relative merits of pure lard oil and other cutting lubricants on the market. While some of the lubricants are useful for certain classes of work, they do not give as good results when cutting steel as can be obtained by a good grade of lard oil. After being used for a considerable time, lard oil seems to lose some of its good qualities as a cooling compound. There are several reasons for this: Some manufacturers use the same oil over and over again on different materials, such as brass, steel, etc. This is objectionable, for when lard oil has been used on brass it is practically impossible to get the fine dust separated from it in any centrifugal separater. When this oil is used on steel, especially where high-speed steels are employed, it does not give satisfactory results, owing to the fact that when the cutting tool becomes dull it generates sufficient heat to "melt" these small brass "chips," so that they freeze to the cutting tool and thus produce rough work. The best results are obtained from lard oil by keeping it thin, and by using it on the same materials—that is, not transferring the oil from a machine in which brass is being cut to one where it would be employed on steel. If the oil is always used on the same class of material it will be found that it does not lose any of its good qualities.

BLANKING AND SHAVING DIES FOR TYPE-SETTER FORK

By A. C. LINDHOLM*

In order to reduce the cost of manufacturing the sheet metal piece shown in Fig. 1, the sub-press dies shown in Figs. 2 and 3 were designed and carefully made. Previous to the new method, the piece, which is called a type-setter fork, was roughly blanked. Then the holes *A* were punched, and the metal removed from the inside of the fork to allow a formed cutter to enter and mill the teeth *B* and the edge *C*. The edge *C* was milled so that it would present a smooth working face for a roller. The final operation consisted in placing the piece on pins in vise jaws and milling the working point from *D* to *E* with a formed cutter. The percentage of pieces spoiled through errors in machining by this method

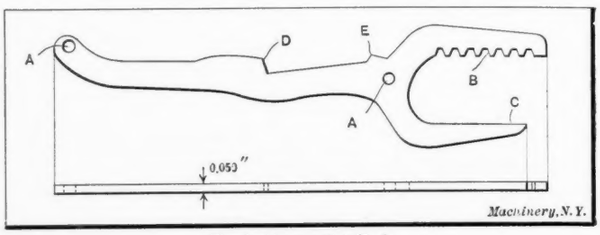

Fig. 1. Type-setter Fork

was excessive and, therefore, the parts passing inspection came high, as every piece required a thorough test.

The dies shown in Figs. 2 and 3 eliminated all the trouble, and as for inspection, the burr was about all that was necessary to look out for. As a rule a piece is generally O. K. if cut clean. Fig. 2 is the blanking die which is of the follow-type, placed in a sub-press or post construction. The die *A* has a section *B* fastened to it by means of screws *C* and dowel-pins *D* and *E*. The pin *E* also acts as a stop-pin for the stock, when taking the first blank from the sheet. The

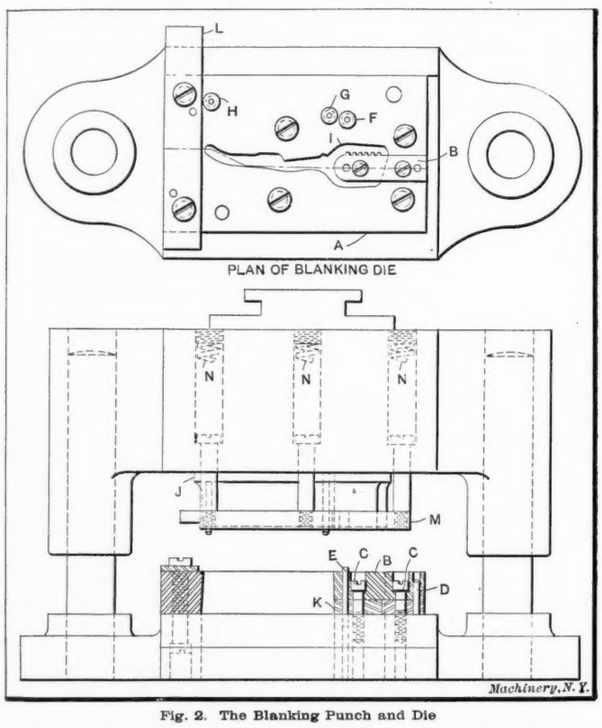

Fig. 2. The Blanking Punch and Die

locating hole in the sheet is punched in the inserted bushing *F* at the same time as the pilot holes *G* and *H*. In starting a sheet, the edge of the strip is placed near the edge of the opening in the die at *I*. The ram then descends and the pilot holes and the locating hole in the blank are pierced. To make the first and the successive blanks, the locating hole in the sheet is placed over the pin *E*. Of course, the pin *E*

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is small enough to allow the pilots on the punch *J* to locate the work properly. The cross-sectional view illustrates the construction of the die with regard to the sectional or inserted piece *B*. As will be seen, one end of *B* rests on part of the die which is cut out to receive it, while the other end is supported by the piece *K*. *L* is the guide-plate, and *M* is the stripper, which in this case is fastened to the upper member of the sub-frame, and is actuated by the six springs *N*, three of which are shown.

The small punches (not shown) for piercing the holes in the blank are supported in bushings located in the stripper, thereby assuring rigid support, and thus avoiding breaking the punches. It will be noted that the die is not "nested"—that is, that there is no groove cut to fit the two sides of the die. This practice is rapidly proving to be preferable to that of nesting, owing to the fact that it is more economical in making the die, and also in placing it in the desired position. Good substantial screws and dowel pins should be used. The same method applies to the punch. Instead of nesting or inserting the shanks, as the case may be, the punch has a shoulder or flange. Although this may seem more expensive to make, it is in reality cheaper considering the advantage over the inserted method; as for instance, when shearing the punch in the die, the upper member is utilized for the purpose and when the punch has been hardened it can be placed to advantage to fit the die. If it has warped so that it is not square with flange or base, it can be speedily corrected. Of course, as in the case of the die, substantial screws and dowels should be used.

Fig. 3 shows the die used for the second operation, which consists in shaving the blank. The same pattern of sub-press

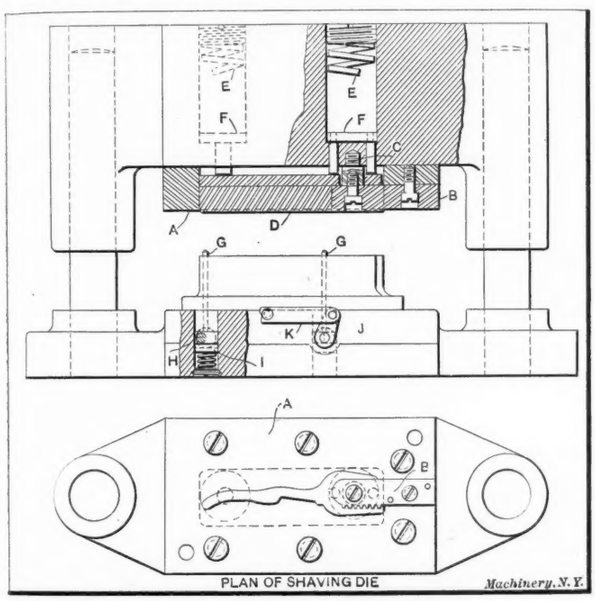

Fig. 3. The Shaving Punch and Die

frame is used, and the same method of fastening the die and punch to their respective members is followed, as in the preceding case. The die, however, is fastened to the upper member and the punch to the lower. The die is practically a copy of the blanking die, except that more care is exercised in machining, as the product from this tool must fit the gage. Referring to the die *A*, the support under the inserted part *B* is a stud *C* screwed into the cast-iron holder, one end being tapped for the fillister-head screw which fastens the inserted member to the stud. The shedder or ejector *D* is made in two parts. When making the punch, sufficient length is allowed and cut off for this member. A flat plate is fastened to it by screws or rivets as the case may be. A hole is drilled for clearance to allow the plate freedom in working.

Two spiral springs *E* actuate the shedder through the plungers *F*. In order to release the work from the gage-pins *G*, a contrivance shown in the cross-section is used, and consists of two rods with eccentrics *H* turned on one end. The eccentric operates in a slot in the plunger *I*. The eccentric rods have cranks *J* fastened to one end which are joined together by the link *K*, the latter having a small handle attached to it, to assist in operating it.

The amount of stock shaved from each edge is about 0.004 inch. This leaves a smooth cut, and with proper care in reference to keeping the die sharp, good work free from burrs is obtained. In shaving dies the same rule applies as in gear-cutters—that is, keep them sharp; if used in a dull state the edges become rounded very quickly and require much more grinding, whereas, if taken in time all that is necessary is to grind off from three to five thousandths inch.

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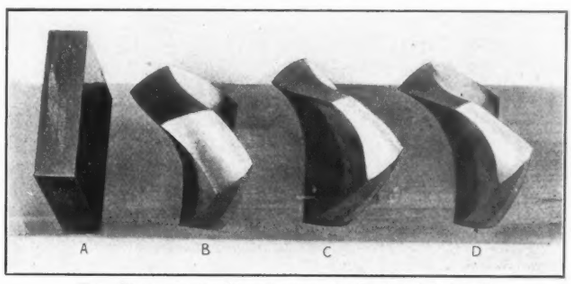
EVOLUTION OF A FLAT TWISTED DRILL POINT

The accompanying illustration shows four of the stages in the manufacture of a flat twisted drill. The illustration shows at *A* an end view of the rough flat stock from which the drill is made. At *B* is shown the end of the drill after having been twisted, but before it is ground or thinned down to the proper thickness for the drill point. It will be seen that the section at the point is entirely too thick to be used as a drill point, and that a great amount of grinding is required to reduce



Four Stages in the Manufacture of a Flat Twisted Drill

the point to a suitable width. In fact, the width of the point is even greater than the thickness of the flat stock from which the drill is twisted, on account of the angle that the line at the point makes with the original flat side of the stock. It will also be seen that the cutting edge or lip is not a straight line, as it should be for efficient action, but that it is decidedly curved. At *C* the point is shown partly ground to the correct thickness, the curve of the cutting lips being less pronounced; in fact, one part of the cutting edge has assumed a straight line form, while the remainder still has the original curved shape; the thickness of the point is also too great for the purpose of the tool. At *D* the finished drill point is shown, the cutting lip here being a straight line and the point reduced to the proper thickness.

It is apparent that the process of grinding or thinning the point of the drill and straightening the form of the cutting lips is a slow, difficult and costly one, on account of the fact that it must be done by hand. As this grinding is done only at the point when the drill is manufactured, the web being otherwise of the same thickness as shown at *B*, it is also evident that when the drill is later ground for sharpening after having been dulled, and it is shortened, it must be ground in the flute by the user in order to obtain a point of the proper width and straight cutting lips. It is evident that this is a difficult operation for the user, and this, in fact, is one of the disadvantages of the regular type of flat twisted drills, otherwise so efficient, and has been the cause of several attempts to improve the drill, by constructing it in such a manner as to make the grinding easier, and make the use of a machine for this purpose possible.

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An analysis of the causes of all accidents to aeroplanes at the British meets last fall shows that out of 40 accidents, 13, or 32.5 per cent, were due to the failure of the engine; 10, or 25 per cent, were due to descents on bad ground; 6, or 15 per cent, were due to sudden gusts of wind which the stability of the machine was not able to resist; 5, or 12.5 per cent, were due to breakage of the propeller, and 6, or 15 per cent, were due to fire and miscellaneous causes.

METHODS USED IN MANUFACTURING THE STEPTOE SHAPER

By G. K. ATKINSON

Some time ago the line of shapers built by the John Steptoe Shaper Co., Cincinnati, Ohio, was redesigned, and since that time a great many of the methods used in the construction of these machines have also been changed. While some of the methods adopted are well known in modern shop practice, there are others which are novel, and which should arouse the interest of the mechanic. The accompanying halftones and line engraving illustrate some of the methods used, and it is the object of the present article to briefly describe some of the more interesting features.

In Fig. 1 is shown the back-gear lever *A*—a malleable iron casting—which is drilled, reamed, and faced to the required dimensions, at *B*, and is then clamped in the slotting fixture

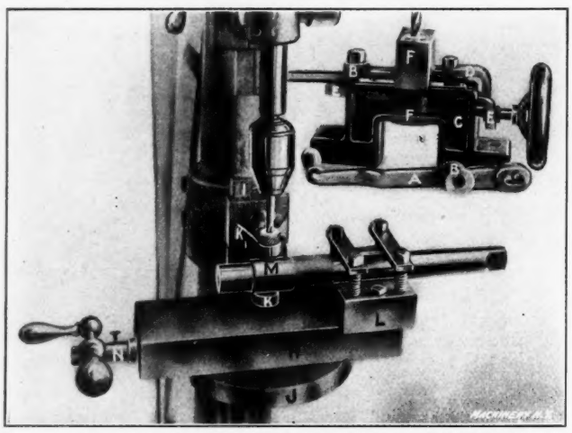

Fig. 1. Two Fixtures used for Cutting Elongated Holes

C, using the hole at *B* as the locating point. Clamp *D* holds it rigidly to the slide *E* on the fixture. The fixture is provided with two hardened bushings at *F*. The lower bushing receives and guides the drill after the lever has been drilled through at *G*, the drill being fed down and through the upper bushing. With the drill in this position the slide *E* carrying the lever *A* is fed by hand across the fixture until it comes in contact with a stop provided. The drill, being

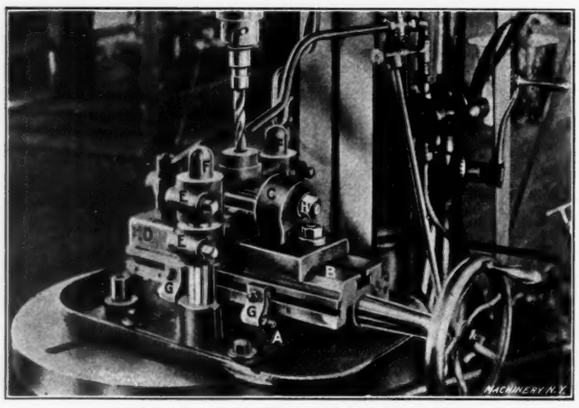

Fig. 2. Fixture for Cutting Slots in Toolposts

guided in the two bushings, makes an ideal spiral milling cutter and produces a good clean slot from the solid stock. The slot is one-half inch wide by one inch long, and one inch deep; the time required to drill and mill the slot is only two minutes.

This fixture suggested the one shown at *H* in the same illustration, which is mounted on the knee of a sensitive drill press, and which consists of a harp and harp-slide from one of the company's regular shaper heads. This fixture is used for cutting the slot in boring and facing bars, and is shown with a facing bar clamped in position for slotting. The vertical part *I* which is bolted and doweled to the back of the harp *J*, supports the two arms *K* and K_1, which carry the bushings for guiding the drill and reamer. The V-block *L* locates and holds the bar *M* in line with the drill spindle and bushings, while being drilled and slotted. The method of cutting the slot is as follows: Assume as an example that a slot 5/16 inch wide and 1¼ inch long is to be cut in a bar which is

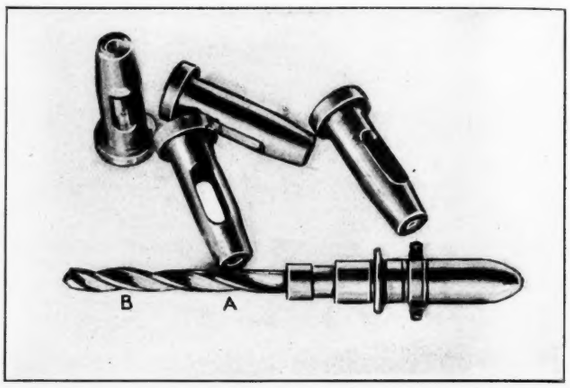

Fig. 3. Some of the Toolposts and the Drill used for Slotting them

clamped as shown. The bar is adjusted by means of the ball crank at the end of the slide until the drill is in position to drill the hole forming one end of the slot. The index collar *N* on the adjusting screw is now set at zero, and the first hole drilled; then the table *H* is fed over a distance equal to 5/16 inch and the second hole drilled, the same operation being

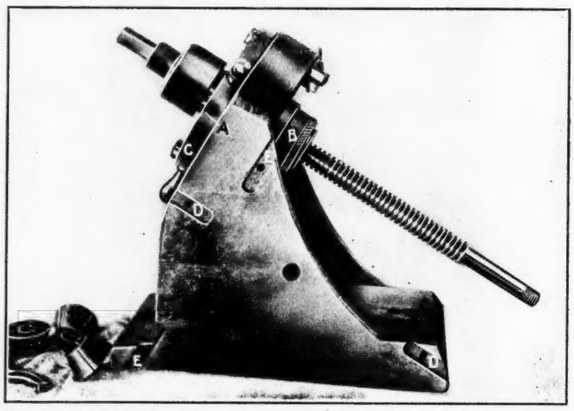

Fig. 4. Fixture for Milling Hexagon and Square Heads on Vise Screws, etc.

performed until four holes have been drilled through the bar. Now a drill having an almost flat or "square" cutting end is substituted, and by means of this the stock between the holes is drilled out. The stock which remains after this second drilling operation is removed by a hand reamer supported by the bushings in the brackets *K* and K_1 below and above the

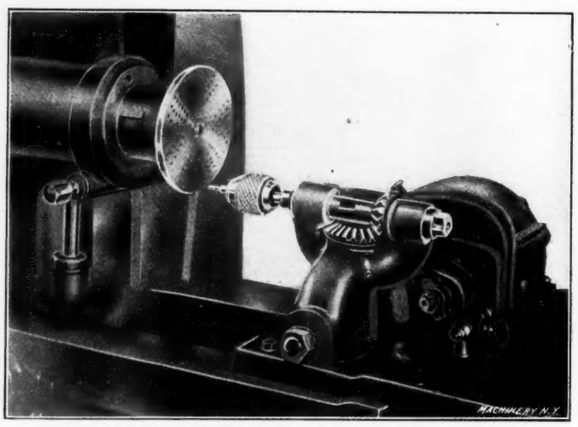

Fig. 5. Device for Drilling Index Plates in a Brown & Sharpe Automatic Gear-cutter

bar. After this operation nothing is left except to square the ends of the slot, which is done by hand.

In Fig. 2 is shown a fixture in which the same idea is carried out in a still more elaborate manner, this fixture being

used for drilling and milling the slot in the toolpost for the shaper. This fixture consists of a base *A* cast integral with an oil pan, a slide *B*, a headstock *C*, a tailstock *D*, drill bushing supports *E*, posts *F*, four stops *G* (two being shown in the illustration and two being placed on the opposite side of slide *B*), and the feed-screw and handwheel. The toolposts are turned, drilled and tapped for the binding screw, and cut off from the bar in a hand screw machine; they are then clamped

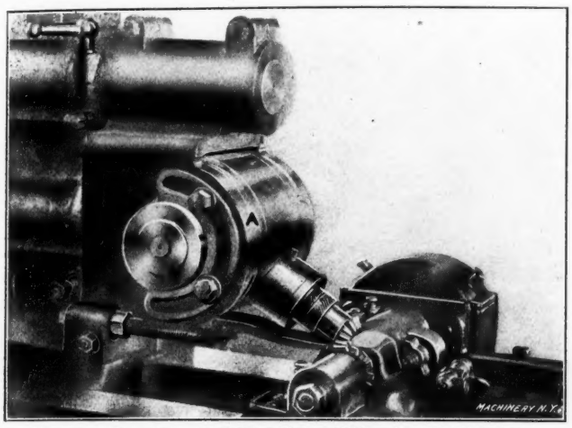

Fig. 6. A Bevel Gear and Face Clutch Milling Attachment for the Brown & Sharpe Automatic Gear-cutter

in the headstock *C* by means of a nut and wedge bolt *H*. The tailstock spindle, which is provided with a bell center, supports the small end of the toolpost. The slide is adjusted by means of a handwheel until the drill conforms to one end of the slot to be cut. The stops are then set for that end of the slot; the drill is fed through the toolpost and well into the lower guide bushing, after which the work is fed across the drill until the slot is cut to the required length, and then the stops at the other end are set for the length of the slot. The subsequent pieces require no measuring, as they are all clamped in the same manner, the stops insuring that they become exact duplicates.

The cutting lubricant is copiously supplied from a tank at the side of the drill press by a pump of the Brown & Sharpe design, bolted to the side of the column, thus permitting the drill to be run at a very high speed. At first, considerable trouble was experienced in finding a drill that would stand

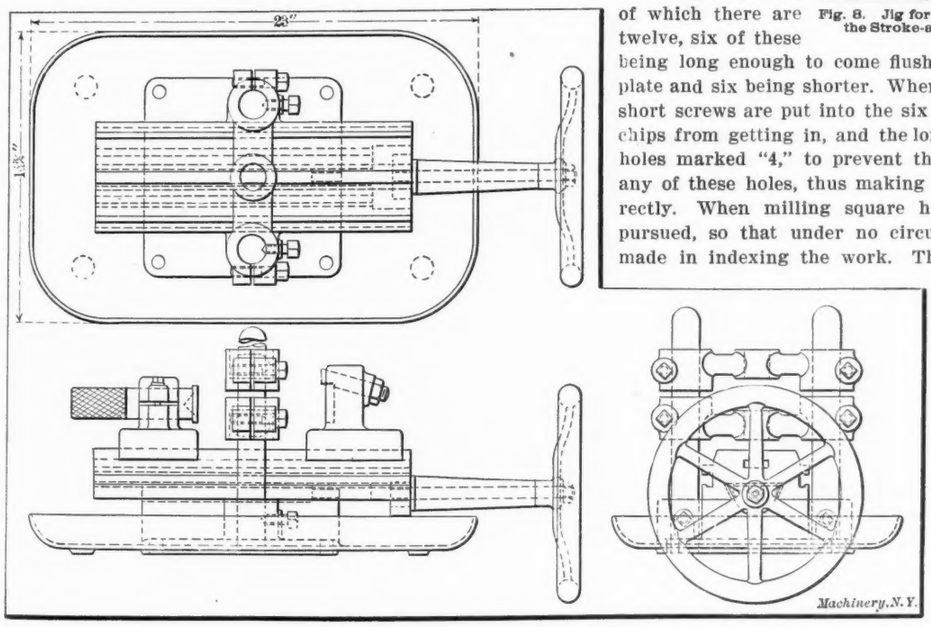

Fig. 7. Construction of Fixture shown in Fig. 2

the side pressure in milling this slot. The ordinary carbon steel drills did not permit of speeds high enough, and the milled high-speed drills would break between the guide bushings. The only drill that has so far been found to work satisfactorily is the Celfor three-fluted twisted high-speed steel drill.

The slot in the toolpost for the 20-inch shaper is 25/32 inch wide by 2 17/32 inch long, and the average time required for drilling and milling the slot complete in lots of 125, is 3.8 minutes for each; the drill mentioned requires only one sharpening for the entire lot without any apparent dulling of the cutting edges. Some of the finished toolposts, and the drill with which they were drilled and milled, are shown in Fig. 3. The drill is backed off so as to have a keen cutting edge between the points *A* and *B*. Fig. 7 shows the toolpost slotting jig. From the description already given with reference to Fig. 2, no difficulty should be experienced in understanding the design. The headstock and tailstock are not shown in position in Fig. 7, except in the side elevation.

The milling fixture shown in Fig. 4 is used for milling hexagon and square heads on vise screws, shafts, bolts, etc. The spindle is provided with a taper bearing, and with a clamping and take-up nut *B*, and is cast integral with the index plate *A*. The jig for holding the work to be milled is provided with a collet for each size piece to be milled. The index plate has ten holes drilled through it, the holes being reamed for a locking pin having a 15-degree included angle. Six of the holes are 60 degrees, and four of the holes 90 degrees apart. After the holes for the index pin have been reamed, they are tapped the remainder of the way through the index plate to permit of the insertion of the round-head cap-screws *C*, of which there are twelve, six of these being long enough to come flush with the back of the index plate and six being shorter. When milling a hexagon head, the short screws are put into the six holes marked "6," to prevent chips from getting in, and the long screws are put into the four holes marked "4," to prevent the locking pin from entering any of these holes, thus making it impossible to index incorrectly. When milling square heads the opposite course is pursued, so that under no circumstances can a mistake be made in indexing the work. The spindle is at an angle of 30 degrees to the base of the fixture, which facilitates the chucking and removing of long shafts or screws having a collar back of the square. The side of the fixture is finished parallel with the spindle, and grooves *D* and *E* are provided for locating-keys which permit the fixture to be turned over on the side and set with the spindle parallel to the milling machine table for milling collar-head screws and work of a similar nature with an end-mill. It is obvious from the location of the grooves *D* and *E* that the fixture may be set either with the spindle parallel with, or at right angles to, the milling machine spindle.

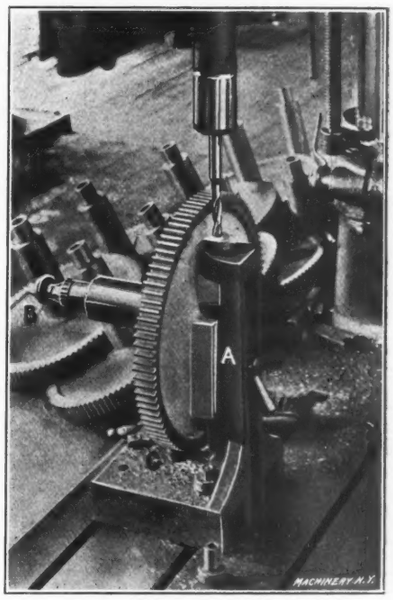

Fig. 8. Jig for Drilling and Reaming the Hole for the Stroke-adjusting Screw in the Bull-gear

In Fig. 5 is shown an interesting drilling fixture for drilling index plates for index centers. The fixture is mounted on the carriage of a Brown & Sharpe automatic gear-cutter, and the index plate is mounted on an expanding arbor in the spindle of the gear-cutter. The plates are made in lots of fifty, and in drilling these, the machine is first set to index the holes in the outer circle. The outer row of holes is drilled in all the plates in the lot, and the machine is then set to index the holes in the second row. All the holes in this row are drilled in all the plates, and so on until the index plate is finished. This method not only insures accurate results, but also eliminates the possibility of errors in indexing.

In Fig. 6 is shown a bevel gear and face clutch milling attachment for the Brown & Sharpe automatic gear-cutter. It will be seen that this attachment is rigidly supported by the overhanging arm, and also has a bearing on the nose of the spindle. It is graduated in degrees at *A* and can be rotated through an angle of 100 degrees, thus having ample range for bevel gears of any angle as well as for face clutches.

In Fig. 8 is shown a jig for drilling and reaming the hole for the stroke-adjusting screw in the bull-gear of the shaper. The bull-gear is located by an eccentric stud *A* and clamped by bolt *B* and toe-clamp *C*, which insures all holes being drilled straight and true with the bearing *A* in Fig. 9. In this latter illustration are shown other drill jigs used for the bull-gear, the bull-gear block and slats. The jig *B* is for drilling the six tapped holes for the slats, and the pin hole shown at *E*. At *C* is shown a jig with an eccentric clamping arrangement for drilling the slat shown in position in the jig. Two more slats are shown in front of the jig and the locating-pin is shown at *D*. The jig is entirely open, thus permitting free access for cleaning.

In Fig. 10 is shown a lathe fixture which holds the vise swivel bolts while the radial portion is being turned on the bolt heads, this portion fitting the T-slot in the vise face. The bolts are slipped into the holes, as shown on the left side at *B*, and are held in place by nuts at the back. The rim *C* is of the same width as the finished bolt head, and serves as a gage for setting the lathe tool. As the fixture holds sixteen bolts at a time, this method of machining them is very rapid and effective. Some of the finished bolts are shown at *D* beneath the faceplate.

The method of milling the belt shifter cam for the triple-geared shaper is shown in Figs. 11 and 12. The cam-cutting fixture is mounted on the lathe carriage, as shown, and the master cam *A* in Fig. 12 is bolted and doweled to a faceplate and is actuated by a roller held in the tailstock spindle, as indicated. The belt shifter cam is mounted on a stud and clamped as shown at *A* in Fig. 11. It is then fed toward the end-mill by the tailstock screw, and revolved by the ball-crank *B* which operates the worm-gear *C*.

* * *

An attractive and convenient method for storing patterns is used in the shops of the R. K. LeBlond Machine Tool Co., Cincinnati, Ohio. Ordinarily, patterns are stored on permanent wooden shelves, which has several disadvantages. All the dirt and dust carried from the foundry with the patterns collects on the shelves. The store-room becomes very dark, and the fire risk is increased. Besides, as the shelves are permanently put in place, some patterns will be found to be too large to go into the space where they properly belong, while the space provided for other patterns is larger than required. In the shops of the above-mentioned company, however, the shelves are made of expanded metal, held in metal frames attached to brackets at the ends, which, in turn, are supported by upright pipes to which the brackets are held by means of set-screws. In this way the shelves can be moved up and down as required by the sizes of the patterns, and the sand and dust cannot collect on the shelves, but falls through the expanded metal to the floor, where it can be easily swept up and removed.

* * *

The working hours of the factories in Cleveland are from 6:30 to 11:30 and 12 to 5 Central standard time. There is a movement on foot to change to Eastern time and begin work at 7 o'clock and stop at 12 and 5:30. The change would mean that work would begin one-half hour earlier than now, and the men would have more daylight time after hours for recreation, etc.

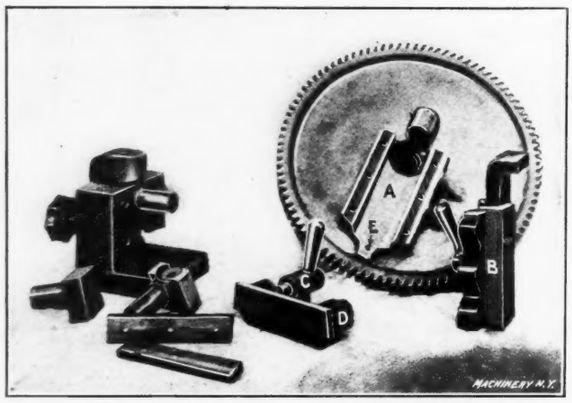

Fig. 9. Jigs for Bull-gear, Bull-gear Block and Slats

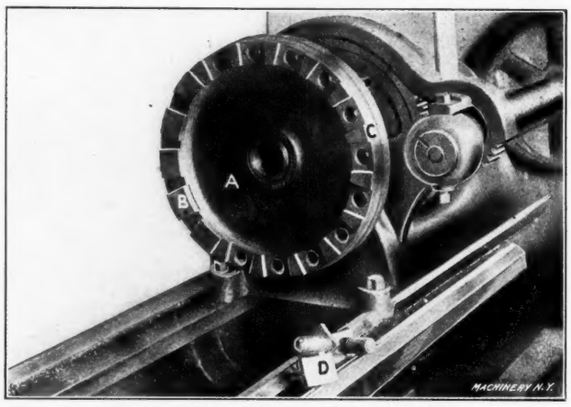

Fig. 10. Method of Turning Vise Swivel Bolts

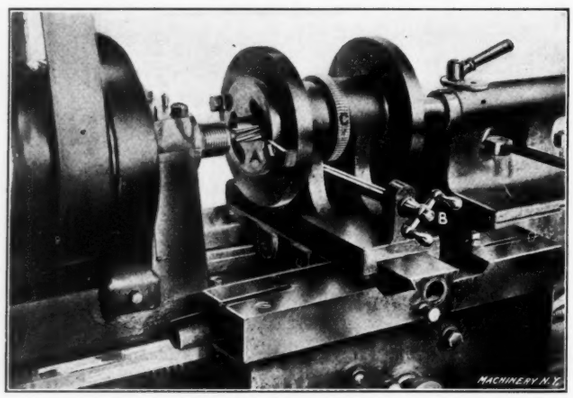

Fig. 11. Milling Belt Shifter Cams in a Lathe

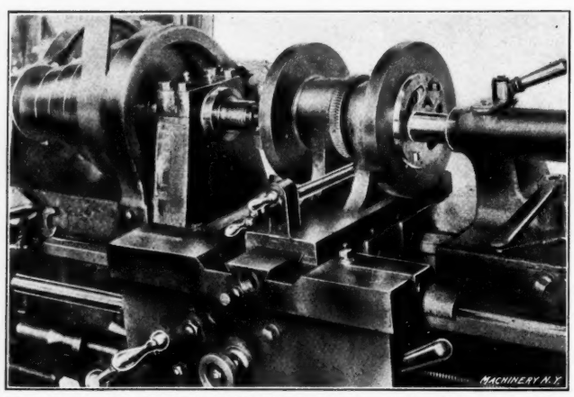

Fig. 12. Master Cam and Guide Roller used when Milling Belt Shifter Cams

EXTERNAL CUTTING TOOLS—5

PRACTICE FOR THE BROWN & SHARPE AUTOMATIC SCREW MACHINES

By DOUGLAS T. HAMILTON*

This article, the concluding installment of the series on external cutting tools, treats of angular cutting tools, shaving tools, shaving-tool holders and feeds and speeds for shaving.

Angular Cutting Tools

When it is necessary to form the end of the work cone-shaped and produce a sharp point, a tool which is fed in similarly to an ordinary cut-off tool does not give satisfactory results. An example of this class of work and the attachment used for forming it are shown in Fig. 20. The work, which is shown at *A*, is a blank for a combination drill and countersink. The angular cutting-off attachment consists mainly of a bracket *B*, which is fastened to the machine by two cap-screws *C*. These screws are located in the holes which are used for fastening the slotting, cross-drilling and burring attachments to the machine. The sliding member *D*, fitting in dovetailed grooves cut in the bracket *B*, is used for holding an ordinary circular forming tool *E*, which is held to this sliding member by cap-screw *F*. The usual means for

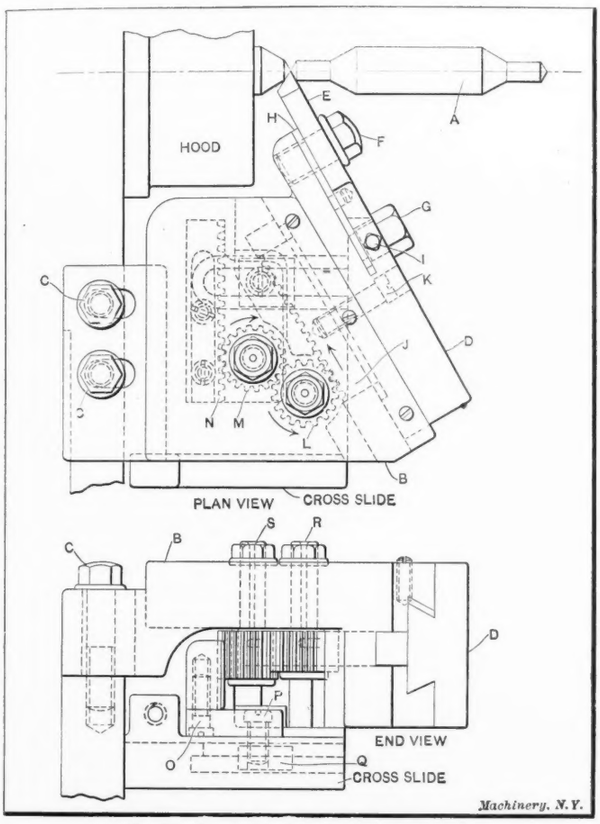

Fig. 20. Cross-slide Angular Cutting-off Tool

adjusting the circular tool is provided; this consists of an eccentric cap-screw *G* and a plate *H*. The eccentric screw *G* is locked by the screw *I*.

Attached to the sliding member *D* is a rack *J* held in a groove cut in the slide, by a fillister screw *K*. This rack meshes with gear *L* which, in turn, meshes with gear *M* in contact with the rack *N*. Rack *N* is attached to the cross-slide by means of a block *O* held in the T-slot cut in the cross-slide, by a block *Q* and two fillister screws *P*. The gears *L* and *M* are held on studs *R* and *S* fitted with bronze sleeves on which the gears rotate. These bronze sleeves are provided with oil grooves, and oil holes are drilled through the studs, so that a copious supply of oil is given to the bearings.

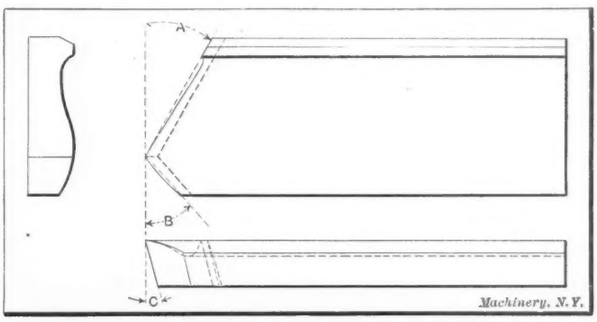

Fig. 22. Shaving Tool for Forming Long Work

The operation of this attachment is as follows: As the cross-slide advances, the rack *N* attached to it, rotates gear *M* which, in turn, through gear *L* and rack *J*, forces the slide *D* in as indicated. Slide *D* is returned to its former position in a similar manner, when the cross-slide drops back. The circular tool *E* follows a diagonal line of travel, so that the point on the work is turned to the correct angle. Thus a very fine point can be made on the work, as no pressure is brought to bear on the part being severed, the weight of the work alone breaking it off.

An angular turning tool which is constructed on a different principle from that shown in Fig. 20 is shown in Fig. 21. This tool is held in the turret, and is operated by a rising block held on the cross-slide. The construction of this tool

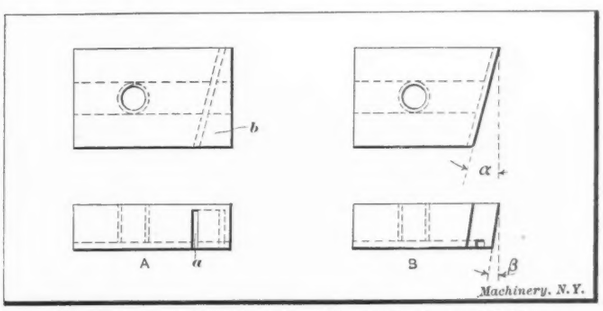

Fig. 23. Type of Shaving Tool used in the Shaving-tool Holder shown in Fig. 24

is as follows: Attached to the body *A* by a shouldered screw *B* is a plate *C*. Tapped into plate *C* is a screw *D*, checked by a nut *E*. The sliding member *F*, fitting over dovetailed ways formed on the angular face of the holder *A*, is attached to the block *C* by means of a screw *G*. The tool-holder *H* is made integral with the sliding member *F*, and holds the turning tool *I*, which is held in a slot cut in the holder, by two headless screws *J*, and rests on a pin *K*.

In operation, as the rising block presses on the screw *D* it swivels block *C* on screw *B*, and as block *C* is attached to slide *F* by screw *G*, it carries the slide along the face of the tool-holder, thus turning the recess in the work as shown at *L*. When the rising block drops back, the tool-slide *F* is returned by a coiled spring *M* held in the body *A*, through a spring plunger *N* pressing against a pin *O* held in the sliding member *F*. A gib and adjusting screws are also provided to make allowance for wear and the free movement of the slide. A bushing *P* held in the body of the holder by a screw *Q* supports the forward end of the work, while the recess is being turned. An angular

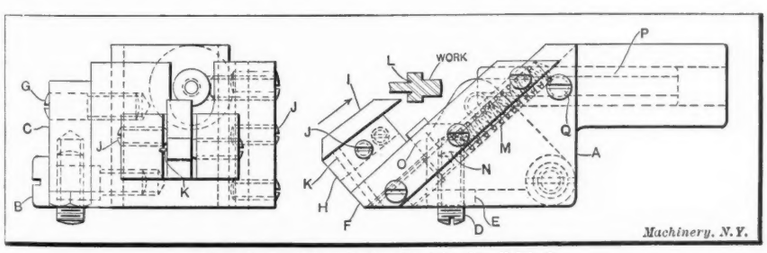

Fig. 21. Back Recessing Tool for Small Work

* Associate Editor of MACHINERY.

cutting-off tool which is held in the turret and operated on by a rising block was illustrated and described in the June, 1908, number of MACHINERY.

Shaving Tools

When forming work of irregular contour, in the automatic screw machines, it is common practice to use a shaving tool, which is operated tangentially to the work and passes either under it or over it as conditions may require. It is customary, however, to place the shaving tool on the rear cross-slide, so that the shaving operation can be accomplished at the same time as the turret operations, when the spindle is running forward.

Shaving tools are made from tool steel containing a high

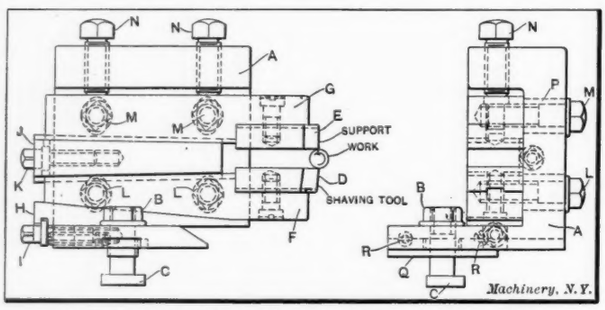

Fig. 24. Shaving-tool Holder which can be used for a Wide Range of Work

percentage of carbon, on the top face of which is formed the irregular contour to be reproduced on the work. High-speed steel, as a rule, does not give very satisfactory results, owing, no doubt, to the fact that to get the best results from this steel, high peripheral velocities must be used. When high peripheral velocities are used, the extreme cutting edge of a high-speed steel tool becomes ragged and will not produce a smooth finish. A brand of steel which has been found very satisfactory for shaving tools is Bohler's special Styrian steel. This steel is extremely fine-grained and produces a high finish on the work. The surface speed, of course, cannot be as great as if a tool made from high-speed steel were used; but this

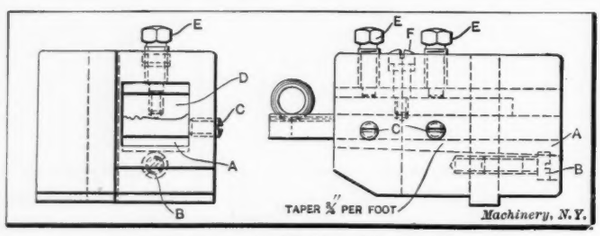

Fig. 25 Shaving-tool Holder of the Box Type

has very little effect on the production of the automatic screw machines where accurate and finished work is the chief requisite.

It is not necessary when applying a shaving tool to the work to incline it at an angle to the horizontal plane to any great extent. The best results are obtained by holding the tool practically parallel, so that when passing under the work the forward end of the tool is at approximately the same height as the rear part. This produces a smooth finish on the work, as the shaving tool burnishes it after removing the material. Holding a shaving tool practically in a parallel plane, obviates the needless and difficult calculations which would be necessary to obtain the shape of the tool if the tool were inclined at an angle.

Shaving tools are used to follow a circular forming tool and produce a smooth finish as well as to completely form the work, finishing it without having rough formed it with any other tool. Where the work has not been roughed down previous to shaving, a larger cutting angle is necessary, and if the work is long in proportion to its diameter the tool should be ground with two cutting angles A and B, as shown in Fig. 22, so that the extreme point of the tool will be where the greatest amount of material is to be removed. This produces a shearing cut and removes the material more easily.

The angles on the type of shaving tool shown in Fig. 22 for cutting the materials specified are as follows:

Material	Cutting Angles in Degrees
Brass rod	$A=20$, $B=30$, $C=10$;
Machine steel	$A=30$, $B=40$, $C=15$;
Tool steel	$A=40$, $B=50$, $C=15$;

While the shaving tool shown in Fig. 22 is used extensively on the automatic screw machines, it is difficult to harden because of its length. If sufficient care is not exercised it will be distorted, and where the contour is of such a shape that it is impossible to grind after hardening, this becomes an objectionable feature. A shaving tool which does not present the same difficulty in hardening is shown in Fig. 23. This shaving tool is a short block which is held in the holder shown in Fig. 24. A support is also provided so that the work need not be supported from the turret except when the length being shaved is long in proportion to the diameter. Owing to the rigidity of the support, the cutting angle can be less than the angle A shown in Fig. 22. The cutting angles on the shaving tool shown in Fig. 23 for cutting the various materials are as follows:

Material	Cutting Angles
Brass rod	$a=10$ deg. $\beta=10$ deg.
Machine steel	$a=15$ deg. $\beta=15$ deg.
Tool steel	$a=20$ deg. $\beta=15$ deg.

The chief use of this tool is for finishing the work after it has been rough formed with a circular form or other external

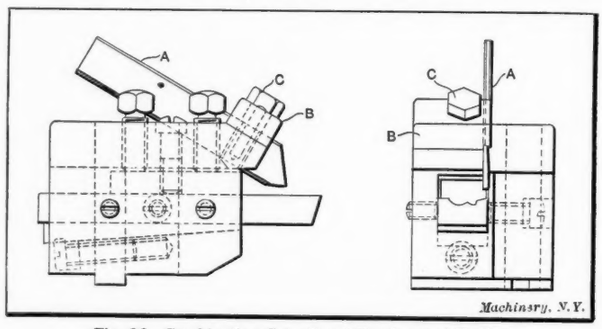

Fig. 26. Combination Cut-off and Shaving-tool Holder

cutting tool. As a support passes over the work after shaving, a burnished appearance is the result; of course, it is absolutely necessary to have the faces of the shaving tool and support polished if good results are to be expected. The first step in making the shaving tool shown in Fig. 23 is to form it into a block as shown at A. A saw slot a is cut at the desired angle, so that the part b can be broken off after the shape required is milled on the top face and the tool hardened and polished. The polishing can be accomplished in a milling

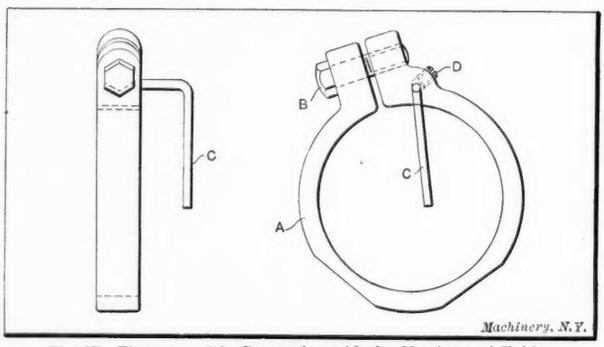

Fig. 27. Ejector used in Connection with the Shaving-tool Holder shown in Fig. 26

machine by holding a piece of brass or copper in a chuck, the outer end of the brass being formed to the contour of the tool. Emery is applied to this lap, and by running the carriage back and forth with the shaving tool held in the vise, a very smooth finish can be obtained. After the tool is polished the part b is broken off and the tool ground as shown at B. By leaving the part b on until the tool is polished, the cutting edge will not be rounded and the tool can be more easily polished.

For cutting machine or tool steel it is preferable to make the shaving tool thinner at the rear end to provide for clearance. Making the tool from 0.001 to 0.0025 inch thinner at the rear than at the front end, gives the desired result. This can be accomplished by packing up the rear end when milling the form on the tool. This type of shaving tool when used on steel should not be used for rough forming, but for finishing only—that is, the work should be rough formed before shaving. Fly-cutters are used in making this tool when

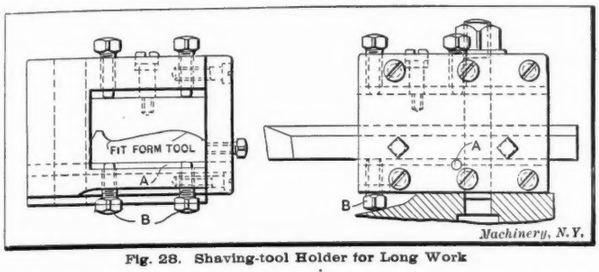

Fig. 28. Shaving-tool Holder for Long Work

the contour is very irregular; but when a large number of tools is to be made it might be advisable to make a formed milling cutter.

When the work is rough formed before shaving and the shaving tool is only used for finishing, the amounts to be removed from the diameters are as follows:

Diameter	Amount to Remove in Inches
1/16 – 1/8	0.0050
1/8 – 3/8	0.0075
3/8 – 5/8	0.0100
5/8 – 7/8	0.0150

Shaving-tool Holders

It is necessary to hold a shaving tool rigidly if good results are to be expected, and if the work is small in diameter in proportion to the length being shaved, it is also necessary to use a support. A shaving-tool holder which will be found satisfactory for this class of work is shown in Fig. 24. This holder is held on the rear cross-slide and consists of a machine-steel body *A*, which is held to the cross-slide by means of the nut and bolt *B* and *C*, the latter fitting in the groove in the cross-slide. The shaving-tool block and support *D* and *E* are held to the two members *F* and *G* by fillister screws as shown. A tongue is formed on members *F* and *G* which fits in grooves cut in the shaving block and support.

The gib *H* is provided for raising the shaving tool *D* to the correct height, being operated on by the collar-screw *I*, fitting into a slot in the gib and screwed into the base of the holder *A*. The gib *J* is provided for increasing and diminishing the distance between the shaving tool *D* and the support *E*, thus governing the diameter of the work. A collar-screw *K*, fitting in a slot cut in the gib *J* and tapped into the holder, is used for adjusting the gib. When members *F* and *G* are set correctly, they are held in the body *A* by means of screws *L*, *M* and *N*. Elongated slots *P* are provided in holder *A*, so as to allow screws *L* and *M* to be moved up and down, which provides for adjustment for different diameters.

The ordinary adjustable block provided in the toolposts for holding circular tools is also provided in this holder. This block *Q* is adjusted by the screws *R*, and is used for setting the side of the shaving tool parallel with the face of the chuck. The front edge of the support *E* should have the same face angle as the shaving tool *D*, but should be set a distance equal to 1/40 of the diameter of the work back from the face of the shaving tool.

It is obvious that a shaving-tool holder of the type shown in Fig. 24 can be used for a wide range of work. The only parts to be made when using it for a different piece of work are the shaving tool and support. The wide range of adjustment also provides for the shaving of different diameters. By making the blocks *D* and *E* of various thicknesses to suit the diameter of the work, a still greater increase in the different diameters that can be shaved is possible.

In Fig. 25 is shown a shaving-tool holder for holding a shaving tool of the type shown in Fig. 22, which is operated from the rear cross-slide. This holder is of the box type, and a tapered gib *A* is provided for adjusting the tool for various heights, which is actuated by the fillister screw *B*, fitting in a slot cut in the gib and screwed into the holder. Set-screws *C* are used to prevent lateral movement of the shaving tool, and a pad *D* operated on by two set-screws *E* is used to hold the shaving tool down on the adjustable gib. This pad *D* is made with the same contour on its lower face as the shaving tool, so that it will hold the latter rigidly. Where the contour of the tool is of a difficult shape to make, it is customary to have the pad bear only on two or three points, which obviates the necessity of putting any more time on the pad than is really necessary. A screw *F* is provided for holding the pad when the shaving tool is removed. The shaving-tool holder is held to the cross-slide in the same manner as the circular-tool holder.

A shaving-tool and cut-off-tool holder combined are shown in Fig. 26. This type of holder is used when the other cross-slide is occupied by a forming tool. The construction is similar to that shown in Fig. 25, except for the additional provision for holding the cut-off tool blade *A*. This is held in a groove cut in the holder, by a block *B* which, in turn, is held by the cap-screw *C*. When using a combination shaving and cut-off tool of this kind, provision has to be made so that the work when cut off will not stay on the shaving tool. A simple

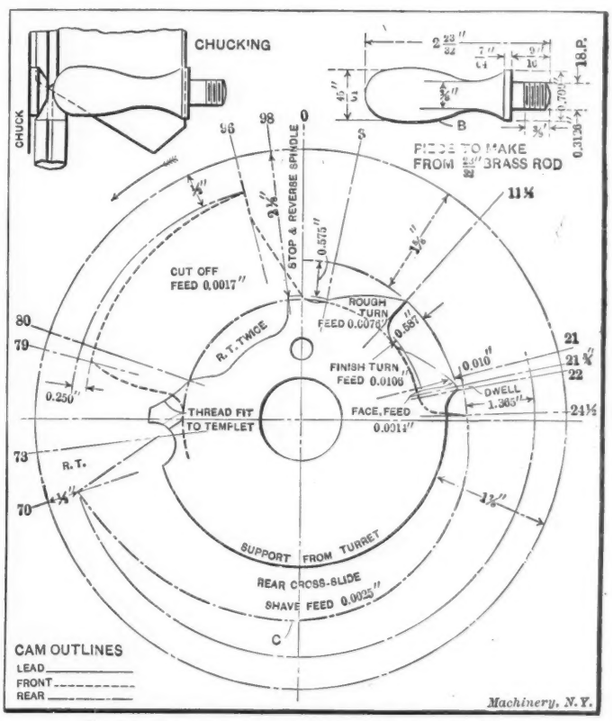

Fig. 29. Cams for making a Handle which is formed by a Shaving Tool

device for overcoming this difficulty is shown in Fig. 27. This consists simply of a split ring *A* which is held on the hood over the chuck by the cap-screw *B*. A wire rod *C*, which is so located that it will remove the work from the shaving tool when the cross-slide drops back, is held in the ring *A* by a headless screw *D*.

In Fig. 28 is shown the holder which was used for holding the shaving tool shown in Fig. 22. This holder differs somewhat from those previously described in that provision is made for raising the front end of the shaving tool. The shaving tool rests on a pin *A* and is adjusted by two set-screws *B*. The object in making this adjustment is to provide for clearance, which is necessary on account of the wide bearing surface. The work for which this shaving-tool holder was designed is shown at *B* in Fig. 29, where the cams for making the piece are also shown. The piece *B* is made from brass and the irregular-shaped part is completely formed by the shaving tool. The lobe which operates the shaving tool is shown at *C* on the rear cross-slide cam. Numerous other designs of shaving tools could be shown, but those described illustrate the types generally used for this class of work.

Speeds and Feeds for Shaving

As a rule, shaving tools can be operated at the same speed as circular form tools, the speeds for which were given in the article entitled "Circular Form and Cut-off Tools" in the March and April, 1910, numbers of MACHINERY. However, as there is more cutting surface in contact with the work, extra precaution should be taken to see that the tool is copiously supplied with lard oil. Provision should also be made for removing the chips, thus avoiding the rough work, which would result should chips become lodged on the face of the shaving tool.

The feed at which a shaving tool can be operated satisfactorily is governed largely by the following conditions:

1. Amount of material to be removed from the diameter.
2. Character of the material.
3. Angle of the cutting edge.
4. Length of the work in proportion to the diameter.

The amount of material to be removed from the diameter should, to a large extent, govern the angle of the cutting edge, and is a more important factor than is the nature of the material. Owing also to the extra amount of cutting surface and insufficient clearance, a shaving tool cannot be fed at the same rate of feed as a circular form tool can. That is to say, to remove the same amount of material from the diameter requires a greater number of revolutions with a shaving tool than with a circular form tool. Where the length of the work is more than three and one-half times its diameter, a support should be used. Provision is made for this in Table VI, and it should be understood that the feeds given under the heavy lines should be used only when the work is supported.

TABLE VI. FEED PER REVOLUTION FOR SHAVING TOOLS

Width of Shaving Tool, in Inches	Smallest Diameter to be Shaved, in Inches										
	1/8	5/32	3/16	7/32	1/4	5/16	3/8	1/2	5/8	3/4	7/8
1/4	0.0025	0.0030	0.0035	0.0040	0.0045	0.0050	0.0060	0.0080	0.0100	0.0120	0.0150
5/16	0.0020	0.0025	0.0030	0.0035	0.0040	0.0045	0.0055	0.0075	0.0095	0.0115	0.0145
3/8	0.0015	0.0020	0.0025	0.0030	0.0035	0.0040	0.0050	0.0070	0.0090	0.0110	0.0140
7/16	0.0010	0.0015	0.0020	0.0025	0.0030	0.0035	0.0045	0.0065	0.0085	0.0105	0.0135
1/2	0.0025	0.0010	0.0015	0.0020	0.0025	0.0030	0.0040	0.0060	0.0080	0.0100	0.0130
5/8	0.0020	0.0008	0.0010	0.0015	0.0020	0.0025	0.0035	0.0055	0.0075	0.0095	0.0125
3/4	0.0015	0.0030	0.0035	0.0010	0.0015	0.0020	0.0030	0.0050	0.0070	0.0090	0.0120
7/8	0.0010	0.0025	0.0030	0.0040	0.0010	0.0015	0.0025	0.0045	0.0065	0.0085	0.0115
1	0.0008	0.0020	0.0025	0.0035	0.0045	0.0010	0.0020	0.0040	0.0060	0.0080	0.0110
1 1/8		0.0015	0.0020	0.0030	0.0040	0.0008	0.0015	0.0035	0.0055	0.0075	0.0105
1 1/4		0.0010	0.0015	0.0025	0.0035	0.0050	0.0010	0.0030	0.0050	0.0070	0.0100
1 3/8		0.0008	0.0010	0.0020	0.0030	0.0045	0.0060	0.0025	0.0045	0.0065	0.0095
1 1/2			0.0008	0.0015	0.0025	0.0040	0.0055	0.0020	0.0040	0.0060	0.0090
1 5/8				0.0010	0.0020	0.0035	0.0050	0.0015	0.0035	0.0055	0.0085
1 3/4				0.0008	0.0015	0.0030	0.0045	0.0010	0.0030	0.0050	0.0080
1 7/8					0.0010	0.0025	0.0040	0.0080	0.0025	0.0045	0.0075
2					0.0008	0.0020	0.0035	0.0075	0.0020	0.0040	0.0070
2 1/8						0.0015	0.0030	0.0070	0.0015	0.0035	0.0065
2 1/4						0.0010	0.0025	0.0065	0.0010	0.0030	0.0060
2 3/8						0.0008	0.0020	0.0060	0.0100	0.0025	0.0055
2 1/2							0.0015	0.0055	0.0095	0.0020	0.0050

It is obvious from the foregoing that the feed should be decreased when the cutting angle is decreased and, on the other hand, the feed should be increased when the cutting angle is increased. The feeds given above the heavy lines in Table VI are applicable to shaving tools having the angles given in reference to Fig. 22, while the feeds below the heavy lines are for shaving tools having the angles given in reference to Fig. 23, and also for the angles given in reference to Fig. 22 when a support is used. When a shaving tool and support of the type shown in Fig. 24 are used, the feeds above the heavy lines in Table VI can be increased 50 per cent with satisfactory results.

* * *

We all respond more or less to the rhythm of motion and sound. So, it is hard to find a laggard in a bustling shop and impossible to keep a spirit of hustle in a draggy one.

TAPS AND TAPPING*

By "A"

Two or three years ago the readers of MACHINERY were treated to some interesting and ably-written articles on taps, their use, and the methods of making them; the contributor of these interesting articles must have thought that he imparted in them all the knowledge it is good for us to have regarding these all-important tools, as we have since been looking in vain for some more such material. It was, therefore, with all the more interest that the writer read the article in the May number of MACHINERY entitled "Square-threaded Taps," dealing with the troubles encountered when using them, and the elimination of some of these difficulties.

The object of the writer in presenting this article to the readers of MACHINERY is to suggest further means and methods for making not only square-threaded taps, but taps with any form of thread, whereby the ultimate object—a straight-threaded hole and a smooth and correctly formed thread—may be obtained. When a smooth and straight-threaded hole is of minor importance and is not necessary, one tap made as outlined by the former contributor will meet the requirements, and is, of course, most economical, as far as the making of the square-threaded tap is concerned. When, however, the threaded hole must be straight and smooth, a different type of tap is required, and where the pitch and lead are coarse, more than one tap is necessary.

Fig. 1 shows a set of taps (1½ inch diameter, 2 square threads per inch) made as the writer would recommend, whereas Fig. 2 shows a set of these taps as generally made. Fig. 5 illustrates the action of the two kinds of taps, and shows the portion of metal that each tap in the set cuts away in the nut. A set of taps made as shown in Fig. 1, with the first tap in the set made as outlined by the contributor in the May number (not indicated in this engraving) will, if otherwise well and properly made, produce the desired results mentioned above. It will be noted that each succeeding tap in the set is cut with a narrower tool, the finishing tap being cut with a tool of the correct width, thus making the teeth

* For additional information on taps and tapping, see the following articles previously published in MACHINERY: "Square-Threaded Taps," May 1911; "Squares on the Ends of Taps and Reamers," April 1909; "Stove-Bolt Taps," March 1909; "The Manufacture of Taps," January and February 1909; "Special and Adjustable Taps," July 1908; "Taper Taps," March and April 1908; "Testing the Lead of Taps and Screws," January 1908; "Acme and Square Thread Taps in Sets," November 1907; "Oversize Limits of Taps," August 1907; "Adjustable Reamers and Taps with Inserted Blades," July 1907; "Remarks on the Making of Hand Taps," June and July 1907 (and the articles there referred to); "Hobs and Die Taps," March 1907; "Machine Taps," February 1907; "Formulas for Determining the Proportions of Taps," January 1907; "Tapper Taps," December 1906; and "Hand Taps with Standard Threads," July 1905.

of each succeeding tap in the set wider, so that each tap will finish the sides of the thread in the nut as well as the bottom. As the amount cut on the sides is not great—merely sufficient to remove any irregularities left by preceding taps and at the same time to smooth up the sides—a hole will be tapped which will leave very little to be desired. Taps as regularly made, as shown in Fig. 2, will invariably produce holes with threads as indicated to the right in Fig. 5; hence, they should not be used when accuracy and smoothness of action between screw and nut are desired, as the bearing surfaces between the screw and nut are but a couple of ridges.

The difficulties encountered when trying to obtain a good square-threaded hole will also be encountered, in a somewhat

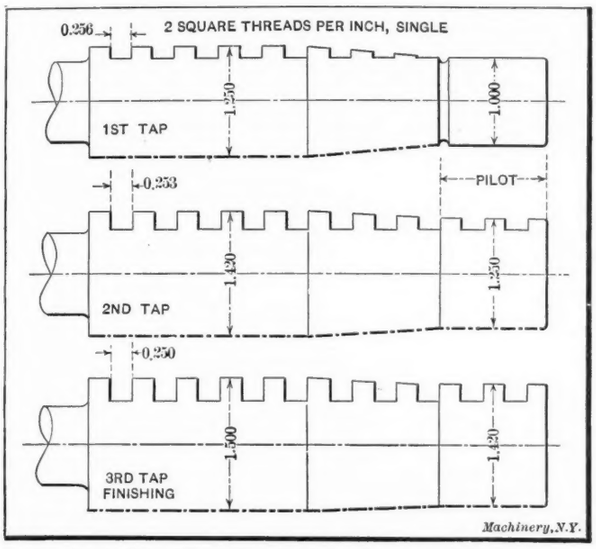

Fig. 1. Set of Square-threaded Taps made as recommended

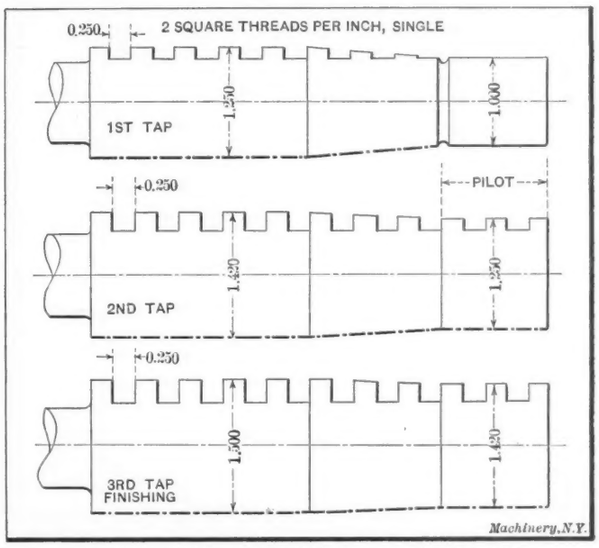

Fig. 2. Set of Square-threaded Taps as ordinarily made

less degree, when trying to produce, with a tap, a good hole with any form and shape of thread. The writer will endeavor to point out in the following some of the defects of taps as generally made, and the means for eliminating these defects, special reference being made to the production of good taps, even if at present they would cost more than taps as now made or manufactured. The makers of taps, however, finding that the remedies suggested actually will cure the defects in the taps and tapped holes, will soon find a way of making the

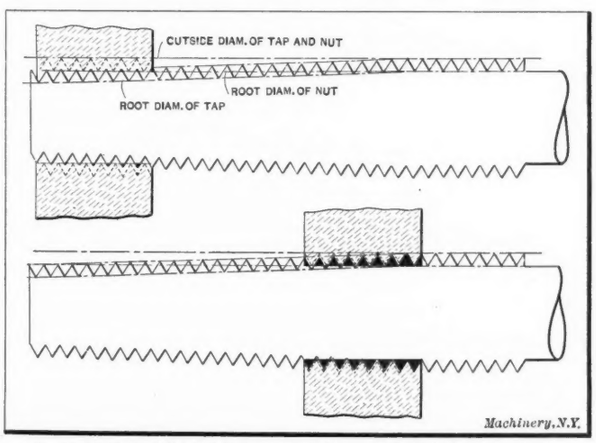

Fig. 3. Tap Threaded with Taper in Bottom of Thread so as to require no Additional Chamfer on the Top of the Thread

more perfect taps with little or no increase in cost over taps as now manufactured.

One of the most commonly found defects in nearly all kinds of taps (hand taps, nut or tapper taps, machine taps, taper die taps, stay-bolt taps, etc.) is the large amount of reaming they are called upon to do when entering the hole to be tapped, and before "taking hold." Any tap user knows that it requires more or less pressure on the tap to make it grip, the amount of this pressure being dependent upon the way in which the tap is made at its small end or point, that is, at the end of the tapered or chamfered portion. It will always be found that the more pressure required to make the tap take hold, the more reaming will be done, and the larger will be the end of the hole being tapped; the result will always be a hole tapered not only at the root of the thread, but in most cases in the angle of the thread as well. Figs. 3 and 6 show the two extreme ways in which taps can be chamfered or tapered, and in Fig. 4 is shown a method embodying a happy medium between the two. When considering the "taking-hold" property of taps and the amount of reaming they do before taking hold, it will be understood and seen at a glance when referring to the illustrations, that a tap made like that in Fig. 6 must

do a great deal of reaming before taking hold in the nut, owing to the wide points on the top of the thread at the end of the tap. It is equally clear that a tap made like that in Fig. 4 will do much less reaming than will a tap made like that in Fig. 6, owing to the fact that the top of the thread at the end of the tap is considerably narrower. A tap made like that in Fig. 3 will have no opportunity whatever of reaming, as the sharp points of the thread immediately take hold in the hole. It must be admitted that a tap made like

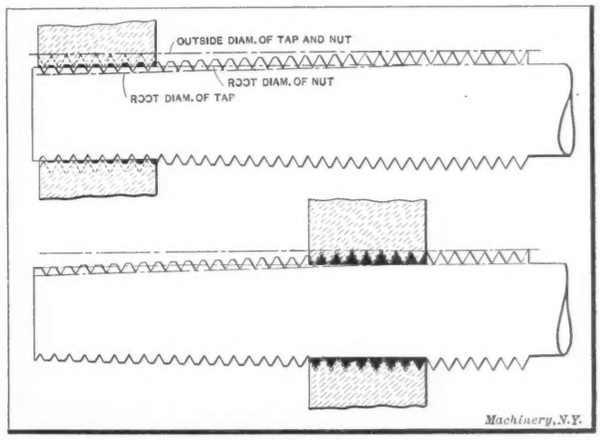

Fig. 4. Recommended Method of Making Taps

that in Fig. 3 is the ideal one to use if the securing of a straight-threaded hole were the only requirement. As, however, a straight hole is not the only thing required—the finish being an equally important factor—a tap made like that in Fig. 3 is not an ideal one, when all conditions are considered; before giving the reason, however, let us look into how the three different kinds of taps have been made.

To more clearly illustrate the conditions, a nut has been shown at the end of each of the three taps, indicating the

amount of metal cut away in the nut when the whole width of the nut has been engaged by the small end of the tap. All the taps must necessarily be small enough on the point to enter the hole in the nut, which, for the sake of convenience, will be considered as being the exact root-diameter. It will be found that taps like that in Fig. 6, are exactly identical with the first or taper taps in a set of hand taps as generally made; that is, the thread is not tapered in the angle, but has the same root diameter the whole length of the threaded portion, and all the cutting is done by the outside of the chamfered portion. Taps made like that in Fig. 3 have been tapered in the angle of the thread an amount equal to the double depth of the thread (when considering the diameter), making a full thread all the way up on the chamfered portion. Taps such as shown in Fig. 4 are made in a similar manner, but the taper in the angle of the thread is equal to the single depth of the thread only. As this tap, as will be explained later, is the ideal one to use when all conditions are taken into account, the writer has prepared the accompanying table, for obtaining the angle and root diameter at the point of taps so made; this table gives the constants to deduct from the standard diameter (on the straight part) to get the angle and root diameter at the point for different pitches and forms of thread.

As was mentioned before, straightness is not the only requirement for a well threaded hole, because the finish of the

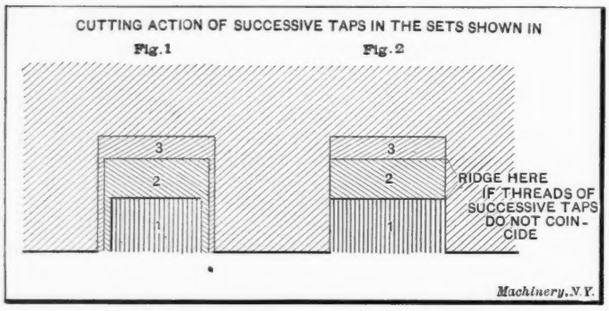

Fig. 5. Action of Taps shown in Figs. 1 and 2

thread is of equal importance. It is evident that the less metal the tapered portion of the tap nearest to the straight part is required to remove, especially if the metal to be removed is distributed all around the thread as shown by the lower views in Figs. 3 and 4, the smoother and better will the finish of the thread be. The lower views in Figs. 3, 4 and 6, of the same taps as are shown in the upper views of the same illustrations, indicate the exact relation between tap and nut, when the nut is ready to engage the straight portion of the thread. From the amount of metal left to be cut away, shown by dotted lines in the illustrations, it may readily be seen that a tap made as shown in Fig. 6 has a very much smaller amount of metal to cut away than have taps made like those shown in Figs. 3 and 4, but it will also be noticed that the metal left to be cut away is on top of the thread only, exactly the same condition existing as that shown to the right in Fig. 5; the thread is thus likely to be left "ragged" on the sides. Taps like those shown in Figs. 3 and 4, as will be seen from the illustrations, have metal left to cut away all around the thread (shown by dotted lines). The amount left, however,

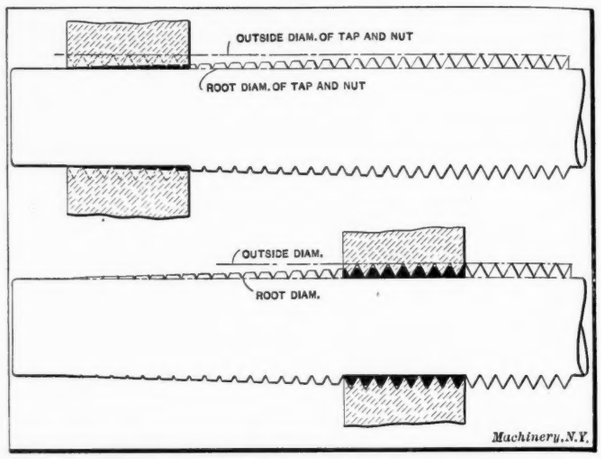

Fig. 6. Tap Chamfered on Top of Thread, having no Taper at Root of Thread

for a tap made as shown in Fig. 3, is too great, and a tap so made will invariably produce a poorly finished thread in the hole. The best tap to use when considering smoothness and finish, is that in Fig. 4; this tap, as will be seen, has metal to cut away all around the thread, the same as the tap in Fig. 3, but the amount left to be cut away is not excessive and, therefore, not detrimental to the finish of the thread. A tap so made is the best one to use, even if it does not take hold in the hole as readily as will a tap made as shown in Fig. 3. The amount of reaming done by a tap thus made is also so small as to be scarcely perceptible.

While the writer has seen and used taps made as outlined in Fig. 4, he has sometimes found that they produced poorly threaded holes; the reason for this was not, however, to be found in any incorrect principle of the taps, but was an entirely different one. As it is very simple, but produces a great deal of trouble, it should be mentioned and a remedy suggested, for even prominent tap makers have failed to take notice of it in such taps as machine taps, long taper die taps, etc. The tap shown in Fig. 4 is generally first threaded straight after having been chamfered; the taper attachment is then set over to the proper taper, and the thread-tool matched in with the straight threads. As this "matching" is done by the eye, it may readily be seen that no matter how carefully the tool is matched in, there is sure to be some

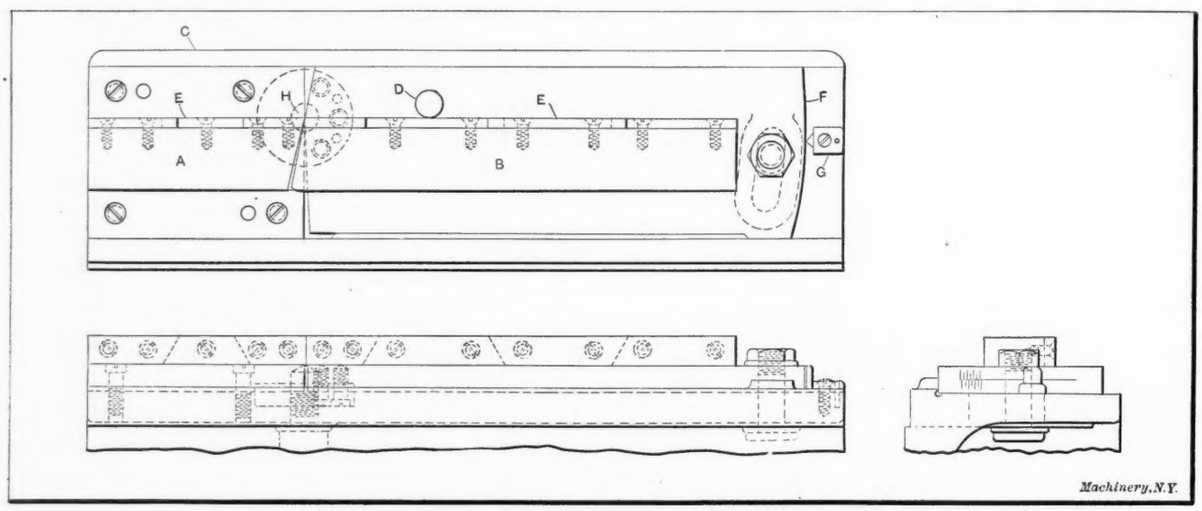

Fig. 7. Taper Attachment for Threading Taps of the Type shown in Fig. 4

error in the matching of the two threads. This error will always cause the taps to bind when reaching the point where the taper thread joins with the straight thread. The threads on the straight part of the tap will also cut on the sides, owing to this error, with the result of a very poor form of thread in the nut, it being generally cut away on one side. To avoid this difficulty, it is necessary to cut the straight and the tapered portion at one setting. When making only one or two taps, this can, of course, be easily accomplished in an ordinary lathe by connecting and disconnecting the taper bar for each tap, without, of course, disturbing the tool. When making taps in quantities, however, this method would not be permissible, owing to the length of time it would consume, and the consequent excessive cost of the taps.

In order to make these taps at a reasonable cost, however, both operations should be performed at one setting. This can easily be accomplished by means of a special taper bar similar to that shown in Fig. 7. This taper bar has a member *A* fixed to base *C* and parallel to the line of centers of the lathe; another member *B* may be set over to any desired taper. This movable member *B* is pivoted at *H*. The center of the stud *H* is located at the center of that edge of the bar against which the taper-bar block or roll *D* travels, and must of necessity be so located, in order that—no matter how much the movable bar is set over—no opening will be produced between the fixed and the movable members of the bar. It will also be noticed that the edge of the bar against which the block or roll travels has steel strips *E* fastened to it, hardened so as to take care of any wear. The outer end *F* of the adjustable member *B* is graduated, and has a pointer *G* to indicate the taper.

A taper bar made as shown should prove to be a valuable addition to any lathe, for, as may be more fully understood from the illustrations, it can do any taper work equally as well as the attachments furnished with regular commercial lathes, and it has the added feature of being able to turn or thread at one setting both straight and tapered parts. The construction might, of course, require some changes for different makes of lathes, but it is safe to say that the changes, additions and modifications made necessary by the adding of such a bar would be many times repaid, considering the extensive use to which a lathe so provided could be put.

* * *

ADVANTAGE OF ASSEMBLING STANDS

When machine tools and other machines are built according to the unit system of construction, that is, when the various mechanisms used in the complete machine are assembled as a whole by themselves, and then these various previously-assembled mechanisms are ultimately assembled to form the completed machine, it makes it very convenient for the assemblers and accelerates the work to a great extent, if assembling stands of an appropriate nature are provided. In several shops in the Middle West, convenient stands are provided for assembling gear boxes, lathe aprons, etc., the stands usually being of a very simple construction, consisting merely of a slight column on the top of which is mounted some kind of an angle plate, joined to the upright in such a way that it can swivel about it in a horizontal plane, and be raised to various positions in the vertical plane. By using such stands the assembler can quickly, and without undue exertion, place the parts in the most advantageous position for rapid and accurate work. He does not need to lift the heavy pieces, thus wasting time and strength. The stands should be placed in an open space, so that the assembler can walk around them and work in any position about the stand that is most convenient.

CONSTANTS TO BE DEDUCTED FROM THE STANDARD DIAMETER OF THE STRAIGHT PART OF THE TAP TO OBTAIN ANGLE AND ROOT DIAMETER AT STRAIGHT PART AND AT POINT OF TAP

Number of Threads per Inch	United States Standard Thread*			Theoretical V-thread*			Whitworth Thread*		
	For A. D., Straight Part	For R. D. Straight Part, and A. D. at Point	For R. D. at Point	For A. D., Straight Part	For R. D., Straight Part, and A. D. at Point	For R. D. at Point	For A. D., Straight Part	For R. D., Straight Part, and A. D. at Point	For R. D. at Point
64	0.0101	0.0203	0.0304	0.0135	0.0271	0.0406	.....	.....	.....
62	0.0105	0.0210	0.0315	0.0140	0.0280	0.0420	.....	.....	.....
60	0.0108	0.0216	0.0324	0.0144	0.0288	0.0432	0.0107	0.0213	0.0320
58	0.0112	0.0224	0.0336	0.0149.	0.0298	0.0447	.....	.....	.....
56	0.0116	0.0232	0.0348	0.0155	0.0309	0.0464	.....	.....	.....
54	0.0120	0.0240	0.0360	0.0160	0.0320	0.0480	.....	.....	.....
52	0.0125	0.0250	0.0375	0.0167	0.0334	0.0501	.....	.....	.....
50	0.0130	0.0260	0.0390	0.0173	0.0346	0.0519	.....	.....	.....
48	0.0135	0.0271	0.0406	0.0180	0.0360	0.0540	0.0133	0.0267	0.0400
46	0.0141	0.0282	0.0423	0.0188	0.0376	0.0564	.....	.....	.....
44	0.0148	0.0295	0.0443	0.0197	0.0394	0.0591	.....	.....	.....
42	0.0155	0.0310	0.0465	0.0206	0.0412	0.0618	.....	.....	.....
40	0.0162	0.0325	0.0487	0.0217	0.0434	0.0651	0.0160	0.0320	0.0480
38	0.0171	0.0342	0.0513	0.0228	0.0456	0.0684	0.0169	0.0338	0.0507
36	0.0180	0.0361	0.0541	0.0241	0.0481	0.0722	0.0178	0.0356	0 0534
34	0.0191	0.0382	0.0573	0.0255	0.0510	0.0765	0.0188	0.0377	0.0565
32	0.0203	0.0406	0.0609	0.0271	0.0542	0.0813	0.0200	0.0400	0.0600
30	0.0216	0.0433	0.0649	0.0289	0.0578	0.0867	0.0213	0.0427	0.0640
28	0.0232	0.0464	0.0696	0.0309	0.0618	0.0927	0.0229	0.0458	0.0687
26	0.0250	0.0500	0.0750	0.0333	0.0666	0.0999	0.0246	0.0493	0.0739
24	0.0271	0.0541	0.0812	0.0361	0.0722	0.1083	0.0267	0.0534	0.0801
22	0.0295	0.0590	0.0885	0.0394	0.0788	0.1182	0.0291	0.0582	0.0873
20	0.0325	0.0650	0.0975	0.0433	0.0866	0.1299	0.0320	0.0640	0.0960
18	0.0361	0.0722	0.1083	0.0481	0.0962	0.1443	0.0356	0.0712	0.1068
16	0·0406	0.0812	0.1218	0.0541	0.1082	0.1623	0.0400	0.0800	0.1200
14	0.0464	0.0928	0.1392	0.0619	0.1238	0.1857	0.0457	0.0915	0.1372
13	0.0499	0.0999	0.1498	0.0666	0.1332	0.1998	0.0493	0.0985	0.1478
12	0.0541	0.1082	0.1623	0.0722	0.1444	0.2166	0.0534	0.1068	0.1602
11	0.0590	0.1181	0.1771	0.0787	0.1574	0.2361	0.0582	0.1164	0.1746
10	0.0649	0.1299	0.1948	0.0866	0.1732	0.2598	0.0640	0.1281	0.1921
9	0.0722	0.1443	0.2165	0.0962	0.1924	0.2886	0.0712	0.1424	0.2136
8	0.0812	0.1624	0.2436	0.1083	0.2166	0.3249	0.0800	0.1601	0.2401
7	0.0928	0.1856	0.2784	0.1237	0.2474	0.3711	0.0915	0.1830	0.2745
6	0.1082	0.2165	0.3247	0.1443	0.2887	0.4330	0.1067	0.2134	0.3201
5½	0.1181	0.2362	0.3543	0.1575	0.3150	0.4725	0.1164	0.2328	0.3422
5	0.1299	0.2598	0.3897	0.1732	0.3464	0.5196	0.1281	0.2562	0.3843
4½	0.1443	0.2886	0.4329	0.1925	0.3850	0.5775	0.1423	0.2846	0.4269
4	0.1624	0.3248	0.4872	0.2165	0.4330	0.6495	0.1601	0.3202	0.4803
3½	0.1856	0.3711	0.5567	0.2474	0.4948	0.7422	0.1830	0.3660	0.5490
3¼	0.1998	0.3996	0.5994	0.2665	0.5330	0.7995	0.1970	0.3940	0.5910
3	0.2165	0.4330	0.6495	0.2887	0.5774	0.8661	0.2134	0.4269	0.6403

* A. D. = angle diameter; R. D. = root diameter

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MACHINERY

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MACHINERY is published in four editions. The practical work of the shop is thoroughly covered in the Shop Edition, $1.00 a year, which comprises approximately 700 reading pages. The Engineering Edition—$2.00 a year, coated paper $2.50—contains all the matter in the Shop Edition, about 300 pages a year of additional matter and forty-eight 6 x 9 Data Sheets filled with condensed data on machine design, engineering practice and shop work. The Foreign Edition, $3.00 a year, comprises the same matter as the Engineering. The Railway Edition, $2.00 a year, is a special edition including a variety of matter for railway shop work—same size as Engineering and same number of Data Sheets.

WHEN BUSINESS IS QUIET, PUSH HARDER

It is surprising what a difference push will make in business results. In a comparison of two concerns of equal size and resources and with products of equal quality, let one concern lie on its oars and wait for business to revive before making any more than the usual effort, while the other concern just doubles its push for business. What will a comparison of the two businesses show at the end of a year, and is the one that has fallen behind likely to regain its loss?

In which class do you belong?

* * *

MANUFACTURERS' RIGHTS

The policy of some manufacturers in the machinery industry, as well as in others, who have endeavored to fix the price at which their product should be sold by dealers, was recently overturned by a decision of the Supreme Court in connection with the sales of patent medicines at cut rates, which allows the manufacturer to fix the price to the distributor, but denies him the right to regulate the price at which the distributor shall sell. The general tendency in all trades and industries is to widen rather than to restrict competition; and this decision will increase and confirm this tendency.

Generally speaking, a reduction in price, whether by cutting or otherwise, stimulates demand; but price cutting, especially when the sale of a product is comparatively limited, as is the case with machine tools and small tools, is more likely to demoralize business than to increase it. It means simply that one dealer is trying to get ahead of another, and the eventual result is that every dealer reduces his price until he reaches a point where he can no longer handle the product without loss. This is certainly not a desirable condition in any industry.

While the manufacturer no longer has a legal right to control distributors' prices, the heroic remedy which was applied by a well-known concern is always open to him. In the case in question the agency was discontinued, and orders amounting to some $300,000 were cancelled because of persistent price cutting on the part of the agent.

STANDARDIZATION OF AUTOMOBILE STOCK PARTS

If all the valuable papers read before the American Society of Mechanical Engineers were forgotten and all its work of standardizing engineering practice were lost except that of formulating and adopting the United States or Sellers standard screw threads—and thus bringing order out of the chaos of screw pitches—the mechanical world would still be in debt to the society. The annual saving in the cost of manufacturing machinery and appliances of all kinds due to the simplification of this detail alone can hardly be overestimated.

The standardizing of mechanical details has become a paramount issue in every field; and we note with great satisfaction that the Society of Automobile Engineers—one of the youngest of the engineering bodies—has undertaken the task of simplifying the mechanical details of automobiles. The need of this work is great, and few outside of the industry have a full knowledge of the immense number of sizes and varieties of common automobile parts. For instance, there are three or four hundred sizes of automobile lock washers between 3/16 and ½ inch, more than there should be; and manufacturers must make and carry a great variety of unnecessary stock sizes, thus considerably increasing the cost to the user. Clearly both makers and users will be benefited by cutting out useless sizes.

The great variety of details in automobile construction is the result of individual initiative without proper guidance. Designers and draftsmen lacked standards to guide them, and worked out the details to suit their own ideas. It is the aim of the society to compile a handbook of standard practice that will be a guide to automobile designers, and they should and doubtless will use it in the same way that engineers employ the handbooks compiled by the various steel companies. The steel handbooks list the sizes of I-beams, channels, and other structural shapes regularly carried in stock, and the engineer chooses the stock sizes whenever possible, avoiding the delay and extra expense incident to ordering special shapes. In the same way the automobile designer will consult the handbook of automobile standards and avoid choosing a special size of tubing, for instance, for which his concern will have to wait a long time and pay a higher price. Instead he will choose the tubing size nearest to his requirement that is carried in stock.

The aim of the society in the work of standardization is not to restrict original research or design which may result in real improvement, but to place in the hands of designers data that will enable them to avoid the selection of parts which must be made specially and which have no real advantage over the standard parts. The value of this work, we repeat, can hardly be overestimated; and every engineer connected in any way with the automobile trade should lend his influence to promote it.

* * *

COURTESY RETURNS DIVIDENDS

Our observation shows that machinery firms which are noted for their courtesy in receiving visitors, and which freely show their works and methods—within reasonable limits—are generally the most progressive and successful manufacturers in the industry; and the contrary is usually, but not always, the case.

The American method in this respect is quite rapidly extending to European works; and one of our editorial representatives who made a tour of Continental Europe several years ago found that most of the well-known firms did not object to showing their plants and explaining their shop methods. Some of our manufacturers say that their courtesy has been abused by foreign competitors who have visited the plants in this country for the purpose of obtaining ideas surreptitiously to use in turning out imitations of our machines; but we are satisfied that these cases are the exception. It is impossible to keep ordinary shop methods secret in a large plant where a skilled workman can readily obtain a job and in the course of a few months familiarize himself with most of the shop methods and devices in use there.

It is a valuable advertisement for any firm to be spoken of as one where the visitor is well received, and where he is welcome to increase his store of general mechanical knowledge by a circuit of the works. No matter how good the product of a manufacturer may be or how high his standing, an added advantage is gained by being well known for the courteous treatment of visitors.

* * *

NEED OF PRACTICAL APPRENTICESHIP INSTRUCTION

So much attention is being given to the technical instruction of apprentices that there is danger of neglecting the practical manual part of their training. The report of the apprenticeship committee of the National Metal Trades' Association, read by Mr. E. P. Bullard, Jr., chairman, at the recent convention in New York City, sounded a warning note, and the opinion was expressed that while many boys no doubt require school-room work, technical instruction should not be given at the cost of thorough manual training.

"The time has long passed when it is enough to sign a boy, and inform him, as a man in charge of a hardening room informed his successor some twenty-five or thirty years ago: 'Here is the coal; there is the leather; the furnace stands in the corner; the rest is in the air.' It is necessary that systematic work be done in the instruction of the apprentice; work should be carefully laid out in a manner to give him progressive training. His mental training should also be attended to. But it may be there are cases where it would be fully as profitable to the young man and the community if less educational work were tried and more attempted in the way of direct manual teaching.

"The purpose of training an apprentice is to make him a skilled workman, and according to the trend of the trades at the present time where specialization is becoming so pronounced, it is a case of training workmen to become so skilled in their work that they can readily take under their charge and impart to others that knowledge of their skill which makes these other men, men who are not able to become completely educated, best skilled in the class of work that they have to do. There are cases of men who have a varied technical education with but little manual training, who are making most successful leaders of men; but where one such man as this is required, hundreds are demanded who must give not only of their technical knowledge, but of their skill acquired by manual labor oft repeated."

The training that teaches a boy to think as he works, that enables him to use his hands skilfully, and through acquired skill to apply his powers intelligently, is the ideal. More is actually learned by performing a simple task than can be gained from any number of lectures on it. Learning that is of real value is acquired through the hands. But having acquired manual skill, personal efficiency is greatly increased by absorbing the theory of practice also. The teaching of theory and practice should go hand in hand; and for the mass, if not for all, the object should always be to promote manual skill in the practice of an art rather than mere knowledge of it.

* * *

DESIGN OF MULTI-TUBULAR BOILERS OF THE MARINE TYPE*

In the following are given a number of formulas for the design of multi-tubular boilers, the accompanying Data Sheet Supplement containing tables calculated from these formulas and other information useful in the design of this type of boiler.

Thickness of Boiler Shell Plates

The boiler shell should have its longitudinal seams double-riveted, and the rivet holes drilled. A formula commonly used for determining the minimum thickness of the boiler shell plates is as follows:

$$T = \frac{P \times D}{24{,}000}$$

in which

T = thickness of plate,

P = boiler pressure (gage) in pounds per square inch,

D = inside diameter of boiler in inches.

The thicknesses of plates for boilers from 2 to 16 feet in diameter, and for pressures from 80 to 250 pounds per square inch, calculated by this formula, are given in Table I of the accompanying Data Sheet Supplement. These plate thicknesses are the minimum thicknesses permissible.

Dimensions of Stay-bolts

Standard stay-bolts are provided with twelve V-threads per inch, the diameter of the stay-bolts ordinarily varying from ¾ to 1½ inch. In Table II of the accompanying Data Sheet Supplement, the effective diameter of stay-bolts, the corresponding area, and the permissible tensile stress, are given. The stress is based on a permissible load of 6000 pounds per square inch. The same table also gives the maximum area in square inches which can be supported by one stay-bolt at various pressures per square inch, when the stress in the stay-bolt does not exceed 6000 pounds per square inch.

Spacing of Stay-bolts on Flat Surfaces

The pitch or spacing of the stay-bolts may be determined by the formulas given in the following. For fireboxes, furnaces, and back-connections, the two formulas below are used:

$$p = \sqrt{\frac{T^2 \times 112}{P}} \text{ for } \tfrac{7}{16} \text{ inch plate and less,}$$

$$p = \sqrt{\frac{T^2 \times 120}{P}} \text{ for plate over } \tfrac{7}{16}\text{-inch thick}$$

in which

p = pitch or spacing of stay-bolts, in inches,

T = thickness of the boiler plate expressed in sixteenths of an inch; for example, if the thickness of the boiler plate is ¾ inch, then $T = 12$; if the thickness is ⅞ inch, then $T = 14$, etc.,

P = gage pressure in pounds per square inch.

For the boiler heads the formula is:

$$p = \sqrt{\frac{T^2 \times 140}{P}}$$

In this case there are nuts both inside and outside of the plate.

These formulas may be modified for special cases. When the stay-bolts in the boiler heads are provided with a washer riveted to the head, having a thickness of at least one-half of the thickness of the head plate, and a size equal to at least seven-eighths of the pitch of spacing of the stay-bolts, or when the heads have a reinforcing plate riveted either on the inside or on the outside, covering the area stayed, and equal in thickness to at least one-half of the head plate, then

$$p = \sqrt{\frac{(T + t \times 0.8)^2 \times 200}{P}}$$

in which

T = thickness of head plate in sixteenths of an inch, as before,

t = thickness of washer or reinforcing plate, in sixteenths of an inch.

The formula just given can also be used when the head is fitted with an angle iron riveted to the plate, the thickness of the angle iron being at least two-thirds of the thickness of the head plate, and the length of the legs of the angle being at least equal to one-quarter of the stay-bolt spacing. In this case, t in the formula just given, equals the thickness of the angle iron, in sixteenths of an inch.

In Table III of the accompanying Data Sheet Supplement, values of the pitch or spacing of stay-bolts calculated by the general formulas above, are given for plate thicknesses varying from 3/8 to 15/16 inch for the fireboxes, furnaces and back-connections, and from ⅜ inch to 1¼ inch for boiler heads, the working pressures varying from 80 to 250 pounds per square inch. In some cases the values are modified from those obtained from the formulas, for practical reasons. In the illustration in Table IV in the Supplement, the arrangements of standard boiler mountings are shown. The proportion of valves, etc., per square foot of grate area are also given for grate areas varying from 2¼ to 70 square feet.

* With Data Sheet Supplement.

THE DRAFTING-ROOM SYSTEM OF THE AMERICAN LOCOMOTIVE CO.*

By FRED. H. MOODY†

The American Locomotive Co., in its Schenectady plant, has what is probably one of the finest drafting room systems either in America or abroad. This system was originally based on the method employed by the Baltimore & Ohio R. R. for many years in the filing of drawings, correspondence, etc. Under the Baltimore & Ohio system everything in connection with the drafting-room was arranged in such a manner as to be filed along the lines of the alphabetical system to be explained in this article. The system in use by the American Locomotive Co., while originally based upon this, has changed so materially, due to the numerous improvements that have been instituted from time to time, that it is practically a new system with nothing but the basic principle of the old system left.

The first attempt at applying this system to the American Locomotive Co. was made in 1903, just after the locomotive merger; the individual plants at first retaining their identity and carrying on their engineering staffs as before, led to much confusion in the work. It was decided in 1907 to centralize as much of the engineering work as was possible. With that object in view the Schenectady plant was selected as being the one best suited for the purpose, for not only had it the largest individual plant, but it was the most centrally located and best adapted for the purpose.

Fig. 1. General View of Main Part of Drafting-room

The Drafting-room

When in 1907 it was decided to move the engineering departments of the various plants to Schenectady, it was found that the local drafting-room was much too small to accommodate the largely increased staff. It was, therefore, necessary to considerably modify and enlarge the drafting-room arrangement, enlarging it by increasing the length 110 feet, making it now 350 feet long by 56 feet wide. In addition, several other floors of the building have been brought into the service.

The general arrangement of the drafting-room is fairly well shown in the accompanying photograph Fig. 1, which shows the main body of the drafting-room. At the far end is the vault and beyond is the new addition previously mentioned, about one-half of which is devoted to drafting and the other half to clerical work. At the opposite end of the room to that shown are the offices of the chief engineer and his assistants and the superintendent of the general drafting-room; while on the further side of the aisle which divides the room is the library and the correspondence and scheduling department. Within the railing in the foreground the calculating department is arranged. The desks on the left of the aisle are occupied by elevation men, while on the other side all the detail drawings are made.

The type of desks used is clearly shown in the engraving. It will be noticed that they are of a very solid construction, built into position on the floor, thereby doing away with any unsteadiness which might occur, due to the latter being uneven. The tables are of three types: single, with drawers and a three-foot wide top; double, without drawers and a six-foot wide top; and combination, with drawers and a six-foot wide top. They are all 18 feet in length.

Indexing the Cards

The manner of classifying the drawings, or cards as they are called, the basis upon which this system was introduced, will first be explained. This is the principal feature of the system and is one which with slight modifications might be advantageously adopted for a wide range of work. In this scheme the parts of a locomotive are divided into 90 general groups, each group being given a number, the numbers ranging from 10 to 99; thus, group 10 is "ash-pans," 11, "axles," and so on up to 99; every part of the locomotive has a number.

As before mentioned the drawings were originally made in the works where the order was to be completed. As the system was to be uniform throughout the works, some distinguishing mark had to be given to the drawings from the different plants, so for that reason the initial letter was chosen. Thus "S" stands for Schenectady, "B" for Brooks, etc.

Originally there were nine sizes of drawings, but as the work has increased in size, that is to say, locomotive sizes have developed more rapidly than was anticipated, the company has been forced to adopt two new sizes for the erecting cards. The following table gives the number of sheet, size and the details for which each sheet is to be used:

No.	Size	Use
1	12 x 9	Small details and brass work.
2	12 x 18	Small details and brass work.
3	24 x 18	Details.
4	24 x 30	Cylinders, boiler sections, grates, ash pans and tanks.
5	12 x 42	Engine frames, etc., and small designs.
6	12 x 60	Engine frames, etc.

*For additional information on drafting-room systems, see the following articles previously published in MACHINERY: "Drafting-Room of the Taft-Peirce Mfg. Co.," June, 1910; "Standard Drawing-Room Methods," February, 1908 (and the articles there referred to); and MACHINERY'S Reference Series, No. 2, "Drafting-Room Practice."

† Associate Editor of MACHINERY.

No.	Size	Use
7	24 x 42	Cylinders, tender frames and tanks.
8	24 x 60	Boiler elevations and small erecting cards.
9	25 x 66	Ordinary erecting cards.
10	25 x 84	Double-ender erecting cards.
11	25 x 102	Mallet erecting cards.

This covers sizes and shapes to meet all classes of work.

The previously mentioned general groups are further subdivided. For example, the "steam pipe, etc.," group 80 is sub-divided into steam pipe, tee-heads, joint rings, etc. The "tee-heads" subdivision is given a series of numbers ranging from 2000 to 3000; joint rings, 3000 to 4000, etc. Each drawing when completed is given one of these numbers, say 1000, and at the same time all the numbers from 1000 to 1009 are allotted to it, permitting nine further tabulations to be made. Another feature of interest is the manner in which certain sized sheets are allotted to certain work; for example, "steam pipe tee-heads" can be made on sheet size number 2 only; "steam pipe joint rings," on sizes 1 and 2, etc. Experience has shown that these sizes are the best for that particular line, thereby keeping the work uniform. This classification and numbering is looked after by a special drafting-office system index which tabulates all the groups, etc., giving all the details in connection with it. The majority of drawings, however, are made on size 3, which by reference to the above table, will be seen to be the best for general purposes.

It can be seen from the explanation given that the general group number, size drawing, works at which the drawing was made, and number of the drawing in that group, represent four different factors, seemingly with but little connection; it remained to combine these groupings in some simple, logical manner that they might be readily understood. An example will show what was done: Consider group 80, card size 3, Schenectady works, card number 71,660. In the system adopted this would be written as follows: 803 S 71,660. This is readily understood, the first two figures giving the general group number; the third, the size drawing; the letter, the works; and the final group of figures, the drawing number in that group. This arrangement is shown in Fig. 2 where the drawing number is placed in the upper right-hand corner. Below, as shown, are placed the ten tabulations allotted to the drawing as previously mentioned, and opposite to it, the

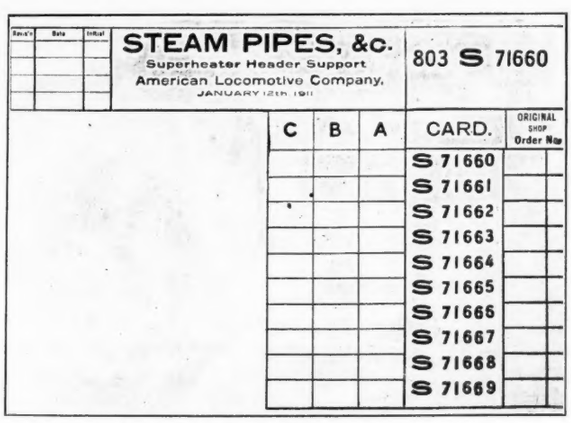


Fig. 2. Tracing Imprint, showing Method of Grouping into General- and Sub-divisions

original shop order number. Should any dimensions be lettered, the space to the left will be ruled to suit, as indicated; however, these tabulations are usually additions.

Immediately to the left of the drawing number is a space containing the name of the group and the sub-group, the company and the date. In the example, "steam pipes, etc.," corresponds to 80 and "superheater header support" corresponds to the sub-grouping 71,000 in general group 80. Further to the left in the small tabulations shown, is a space to be filled in case of any future revision of the drawing. All this corner piece of the drawing is printed in the local press room so that the work is absolutely uniform. Electrotypes of the different headings and sub-headings are kept in stock, so that no mistake in giving the titles can occur.

Record Prints and Blueprint Folios

As is customary in most drafting-rooms, the tracings were used for reference purposes until quite recently, when a new system of record prints was introduced. It was found that the constant handling of these tracings had a very bad effect, in many cases requiring their renewal long before it should have been necessary. Under this new scheme an extra blueprint is made from each tracing, on which, during the blueprinting process a large R, two inches high, is printed, with this legend directly below in good sized letters:

This is the Record Print
Must be treated as an Original
Return to vault promptly

In this way the tracings are saved; they cannot be taken from the vault except when absolutely necessary for changes, retabulating, etc. These record prints, being kept automatically

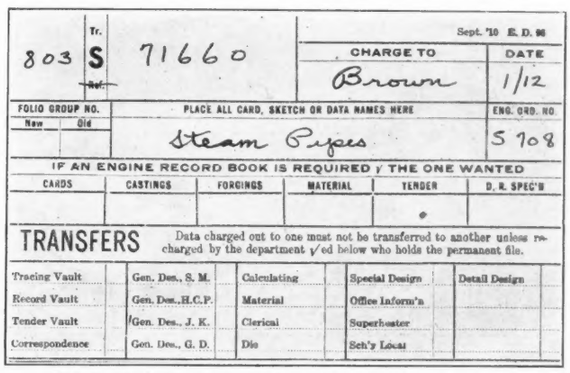


Fig. 3. Vault Slip, for use when taking Drawing from Vault

up-to-date by the blueprint department, are authoritative and serve their purpose equally as well as the tracings. While additional expense is incurred from having to make this extra print, it is more than compensated for by the diminished wear and tear on the tracing.

Further records are kept in the form of blueprint folios, which are loose-leaf books of the blueprints arranged according to their general groups and sizes. These are very convenient for the draftsmen in looking over previous records of what has been done in any particular line.

Vault

The vault for holding all permanent records is located at the end of the old portion of the building, as previously mentioned, and on account of the new addition is now about midway down the drafting-room. The majority of tracings are kept in the vault on the main floor, the only ones not kept there being those belonging to the tender department, which are kept in the vault adjoining that department on the floor above. The main vault has two floors containing tiers of shallow drawers in which the tracings are kept with respect to group, different sized drawers being used according to tracing sizes. These tiers of drawers are so arranged around the wall as to be conveniently gotten at by the clerks. In this vault are also kept any permanent records, such as specifications and the books for castings, patterns, cards and material. The reference prints previously mentioned are kept in tiers of drawers in a room adjoining the vault. Not being of a permanent nature, they do not require to be kept in the fireproof vault, from which they are excluded by reason of the lack of space. The card, pattern, casting and material books, are kept in the vault, arranged according to order number.

Anything in the vault or its adjoining room is let out on an order such as shown in Fig. 3; this card is self-explanatory. It will be noticed that everything kept in the vault is included on this one order card; for example, in the upper left-hand corner, either tracing or reference sheet may be called for by striking out the one not desired, or a folio may be taken out by marking its number; the "old" column has reference to prints made previous to the installation of this new system. Any of the record books may be taken out by checking the one desired. It will be noticed throughout, on

all forms, that whenever possible, checking is used instead of the usual method of writing a name; this proves to be more expeditious in nearly all cases, as well as obviating confusion from poor writing. At the bottom of the card are shown the transferring arrangements, whereby the charge may be removed from the party against whom it is posted, to any of the departments listed, by checking the proper department. As these orders come in they are filed vertically in boxes according to group and their order in the group, where the vault clerk has a record of the location of any particular tracing or reference sheet should it happen to be out of the vault. Upon the return of the tracing, the charge is removed and the slip destroyed.

Each of the principal draftsmen has a light wooden box 20 by 28 by 5 inches deep, in which all tracings are kept while being made, as well as drawings that are awaiting inspection. Each night these boxes around the drafting-room are collected and placed in the vault so that no records of a permanent nature are left around where they may be destroyed.

Personnel

The engineering department is directly in charge of a chief engineer and his assistant and the superintendent of the general drafting-room. Under these come the assistant engineers of whom there are over a dozen. Working in conjunction with all these engineers are three consulting engineers, who supervise the more important designs, or those involving new features; in all other cases, they act in an advisory capacity, assisting in the design when required. They are independent of the general drafting room, reporting directly to

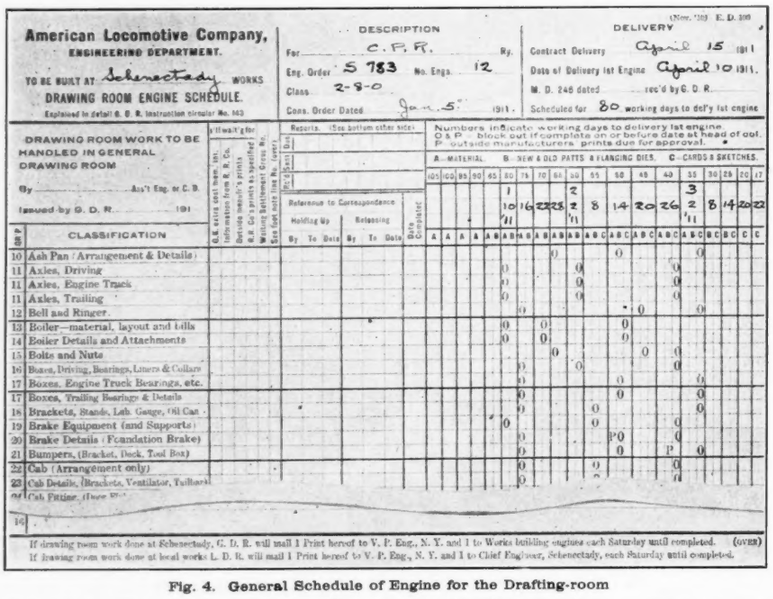

American Locomotive Company,
ENGINEERING DEPARTMENT.
TO BE BUILT AT Schenectady WORKS
DRAWING ROOM ENGINE SCHEDULE.
Explained in detail G. D. R. Instruction circular No. 143
DESCRIPTION
For C. P. R. Ry.
Eng. Order 5783 No. Engs. 12
Class 2-8-0
Cons. Order Dated Jan. 5 1911.
DELIVERY
Contract Delivery April 15 1911
Date of Delivery 1st Engine April 10 1911.
M. D. 246 dated rec'd by G. D. R.
Scheduled for 80 working days to del'y 1st engine
DRAWING ROOM WORK TO BE HANDLED IN GENERAL DRAWING ROOM
Issued by G. D. R. 191
Numbers indicate working days to delivery 1st engine.
C & P block out if complete on or before Date at head of col.
P outside manufacturers prints due for approval.
A—MATERIAL B—NEW & OLD PATTS & FLANGING DIES. C—CARDS & SKETCHES.
105 100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 17
Sht P CLASSIFICATION
10 Ash Pan (Arrangement & Details)
11 Axles, Driving
11 Axles, Engine Truck
11 Axles, Trailing
12 Bell and Ringer
13 Boiler—material, layout and Ills
14 Boiler Details and Attachments
15 Bolts and Nuts
16 Boxes, Driving, Bearings, Liners & Collars
17 Boxes, Engine Truck Bearings, etc.
17 Boxes, Trailing Bearings & Details
18 Brackets, Stands, Lub. Gauge, Oil Cup
19 Brake Equipment (and Supports)
20 Brake Details (Foundation Brake)
21 Bumpers, (Bracket, Deck, Tool Box)
22 Cab (Arrangement only)
23 Cab Details, (Brackets, Ventilator, Tailboard
Cab Fittings (Iron W'k)
If drawing room work done at Schenectady, G. D. R. will mail 1 Print hereof to V. P. Eng., N. Y. and 1 to Works building engines each Saturday until completed. (OVER)
If drawing room work done at local works G. D. R. will mail 1 Print hereof to V. P. Eng., N. Y. and 1 to Chief Engineer, Schenectady, each Saturday until completed.

Fig. 4. General Schedule of Engine for the Drafting-room

the head office in New York. The actual drawing is distributed among eight assistant engineers, four of them in charge of elevation design and four in charge of detail; the detail engineers look after groups of details, their department being divided into smaller sections under section leaders.

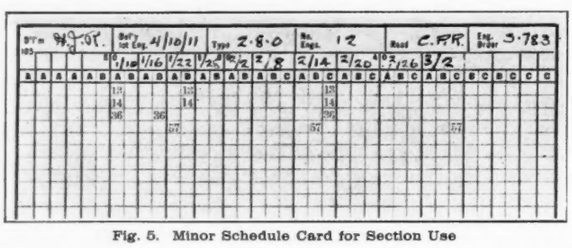


Fig. 5. Minor Schedule Card for Section Use

In addition to the assistant engineers who look after the actual drawings, there are assistant engineers in charge of each of the other departments, such as the material, forgings and dies, standard, office information and calculating departments. All these assistant engineers are on an equal footing, consulting each other when any question regarding a design arises. Matters that cannot be settled in this way are taken to the superintendent of the general drafting-room, the chief engineer or his assistant.

Specifications and Scheduling

The best way to obtain a clear understanding of the workings of the system is to follow an order through the engineering department. The engineering department in New York draws up a contract specification between the purchasing parties and the company; as a rule this is general in its nature and does not enter very deeply into detail. Each order is given a number; thus, "B 783" means Brooks, order number 783. A similar plan is adopted for the other works. A copy of the contract specification with an order to construct is forwarded to the chief engineer at Schenectady, who appoints one of his assistant engineers of elevation to look after the design. Just previous to this, however, the specification is given to an assistant engineer in charge of office specifications and scheduling. This engineer compiles more definite data from the contract specification, elaborating thereon in a special form supplied for that purpose; this form consists of a number of printed pages arranged in the same group order number as previously explained; complete data, as regards material, size of parts, etc., is given in this drafting-room specification. On its front page there is a table containing all of the vital data in connection with a locomotive, such as type, size and kind of cylinders, wheels, etc. As in general these specifications differ but slightly from those to be seen in any engineering office, no further explanation will be given.

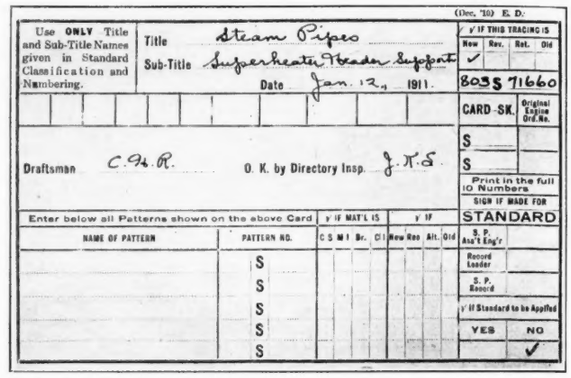

(Dec. '10) E. D.
Use ONLY Title and Sub-Title Names given in Standard Classification and Numbering.
Title Steam Pipes
Sub-Title Superheater Header Support
Date Jan. 12, 1911.
√ IF THIS TRACING IS: New ✓ Rev. Ret. Old
8035 71660
CARD-SK. Original Engine Ord. No.
Draftsman C.H.R. O. K. by Directory Insp. J.F.S
Print in the full 10 Numbers
SIGN IF MADE FOR STANDARD
Enter below all Patterns shown on the above Card
NAME OF PATTERN PATTERN NO. √ IF MAT'L IS C S M I Br. Cl √ IF New Rec Alt. Old
S. P. Ass't Eng'r
Record Loader
S. P. Record
√ if Standard to be Applied YES NO

Fig. 6. Imprint Order Card to be sent to Press Department with Tracing

While these specifications are being compiled, the process of scheduling the work is under way. The contract specification usually states a time delivery for the locomotives. The form for scheduling is shown in Fig. 4, which shows the schedule card for the locomotive on an 80-day basis; similar cards are made out for the tender. On this schedule form complete information is given, but the principal feature to be noted, however, is the scheduling. All the productive work is divided into three general groups: "A," material and specifications; "B," new and old patterns and flanging dies; and "C," cards and sketches.

A little consideration will make it clear that different lengths of time are required for making any particular part, depending upon such factors as the amount of machine work, whether it is purchased on the outside, and other equally important considerations. From long experience the company has been able to form a general schedule showing how long previous to the delivery date it is necessary to have the different details ready. This has been prepared in the department for various delivery periods, ranging from 105 down to 40 days, the former length of time being generally required

for new designs, while a repetition order may be completed within the latter time period, from the fact that in the latter case all drawings, patterns, etc., are ready. Consider an 80-day delivery: From this general schedule the engineer knows just how much time any part requires; from a computing calendar a date for any number of working days ahead can be readily determined. Take, for example, "axles" on an 80-day basis; the material for these must be ordered among the first things. This is shown by the cipher opposite "axles" under list "A" of the 80-day column. The date is placed in the vacant space just above, under the squares containing "75, 70, 65, 60," etc.; these dates are 5, 10, 15 and 20 working days ahead. It will be noticed that the dies for this order on the axles are required on the date set at 60. All cards and sketches must be gotten out on the date corresponding to 40 days. This schedule is kept by the scheduling department, which keeps in touch with all the other departments and sees that the schedule is lived up to. When the allotted time elapses, if the schedule is broken, inquiries are set on foot to ascertain the cause of the delay. When notification of the completion of each of the scheduled events occurs, the square is blocked out; the unblocked squares are the ones to be watched.

Minor cards, such as are shown in Fig. 5, are made up for distribution to the different drawing departments. For example, the one shown is given to the section getting out groups 13, 14, 36 and 57. It shows the day on which their work is expected, and that department is held responsible should the order fall behind on that date. These are usually dated a day or more ahead, in order to give that department time to transfer the drawings, etc., to the next.

Long cards, 22 inches in length, sections of which are shown in Fig. 7, are given to the material department—a separate strip for each order. When each part is completed, as with the other cards, the space is blocked out. The unblocked spaces on the date for which it is specified, are then followed up to ascertain the cause of the delay. The work in all departments is therefore automatically kept moving through at the proper rate.

Elevation and Detail Department

During the time that the work is being scheduled, the assistant engineer of elevation who has charge of the particular order, is making the elevation drawings of the locomotive, which usually include a side view, end view and several cross-sectional views, as well as a partial view from below. This design is purely tentative until passed upon by the calculating engineer, as will be explained later.

When well under way, the engineers in charge of detail are called in; they prepare detail drawings of the parts that come under their respective departments. Such details as the frames, grate arrangements and erecting cards are looked after by the elevation engineer, as the whole arrangement of the locomotive must be considered more particularly in the preparation of these parts.

In the detail department, when a drawing is completed, a slip such as is shown in Fig. 6, is attached to the card or tracing; on it are written the title, sub-title and date. It is then passed to a clerk whose duty it is to record the tracings, and give the drawing a number. It is then sent up to the printing department where a title as shown in Fig. 2 is printed on the drawing in the manner before explained. The drawing is returned to the detail department there checked, and if found correct from its standpoint, is passed to the elevation engineer. The elevation engineer, when it reaches that stage, re-checks the drawing as regards clearance with other parts, etc.; he is then through with it. This checking need not be further explained, being common to all drawing-rooms.

As the elevation engineer passes upon the drawings and finds them to be correct, before sending them on from his department, he enters the drawing numbers in what is called the "Card Book." This card book has the order number in large letters on the cover and is printed throughout with names of parts in the group order number just explained. All that is necessary then is to enter the drawing number opposite the name of the part.

Tender Department

The tender designs are handled in a similar manner except that in this case there is only one engineer in charge of both elevation and detail, who looks after the drawings as they come through in a similar manner to the one explained for the locomotive drawings. The tender department is independent of the rest of the drawing-room and has its own vault where its drawings are kept and from which they cannot be taken except by special order from the general drawing-room superintendent. A card book for tender parts is kept in a similar manner to that explained for the locomotive cards.

Calculating Department

All calculations come under a distinct department, so that the draftsmen have no computations to make. The work of this department commences immediately after the first lines of the locomotive are laid down. When the outlines of the locomotive have been drawn in by the elevation engineer, the calculating engineer goes over this outline and by comparison with drawings of locomotives of a somewhat similar build, is enabled to determine just how the weight of the locomotive is going to be distributed over the wheelbase, and whether this distribution will conform with that specified in the contract specification. The elevation engineer cannot proceed with the design until this information has been determined; so experienced have the engineers become through long practice that an arrangement seldom needs to be changed. If, for example, however, the boiler must be moved back, or other similar change made, the extent of this movement is determined by the calculating department so that the elevation engineer has no figuring to do in the matter, merely following what has been laid down by the calculating department.

While the principal work of this department is to regulate the distribution of weights, other work is also done such as determining the strength of different members—as for example axles, piston-rods and connecting-rods—and the determination of counterbalances, coal and water capacities, strength of springs and designs of brakes. This department must keep in touch with the work all the way through, from the time the order first comes into the drafting-room until the last drawing is completed. Special forms are supplied for all the calculations, so that they are retained in permanent form for future reference.

Inspection

The drawings, as they leave the elevation and tender departments, are inspected by shop men attached to each of the different departments, who examine the drawing in order to determine whether the part can be improved from a manufacturing standpoint, noting in the case of a casting, whether improvements might not be made to facilitate molding. This inspection is made with the sole purpose of facilitating manufacture and merely forms a re-checking of the drawing, for of necessity, the assistant engineers in charge are thoroughly practical men.

Die Department

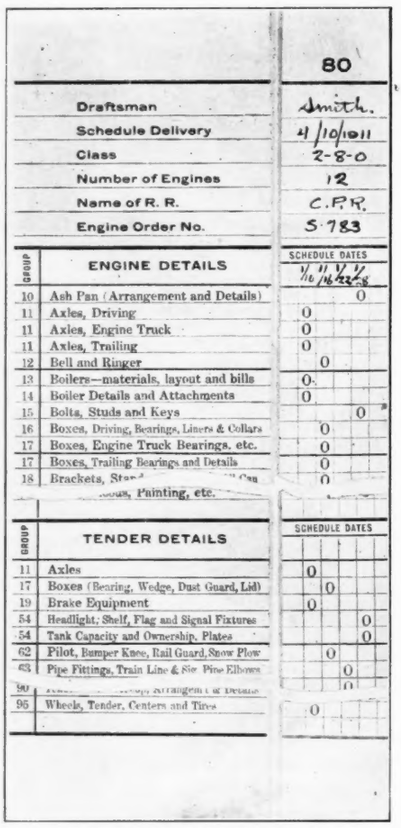
It might here be explained that in the detail department, in addition to the usual cards made of all parts, small cards called "sketches," which are not as complete in detail as the regular drawings, are made of all parts that must go through the smith shop. All sketches on being passed by the elevation men and inspectors, come to the die department where they are examined by the assistant engineer in charge of this department, who determines whether or not it would be possible to produce this part by some machine forging process, such as drop forging, bulldozing, etc. If practicable, drawings are made of the necessary dies, such as flanging dies, etc. This, of course, is not necessary in the case of drop forging work.

All plate work drawings also pass through this department to see if flanging dies cannot be preferably used to facilitate work. Just here it might be mentioned that a very complete

system of adjustable flanging dies is employed by the American Locomotive Co., which are very convenient in such places as the firebox shell, where on different locomotives, varying amounts of slope are given to the walls; having adjustable dies saves the making of many new dies for the purpose.

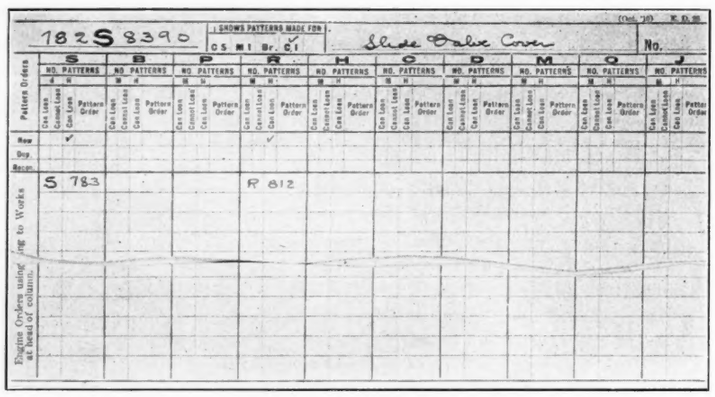
Most of the drawings that have to pass through the machine shop come under the inspection of the assistant engineer of the die-department, and he also determines the practicability of producing tools and jigs to increase machine shop production.

A special series of office information sheets is kept for the tools, dies and jigs. These are made out on standard M.C.B. letter-size tracing linen and are given a group number similar to the larger drawings. The principal difference is in the numbering; for example, with "tools," a "T" is added to the works signification; thus, 932 ST 510 means the tools on a Schenectady drawing. "D" and "J" are similarly added for dies and jigs. These office information sheets give the die or jig number and also the drawing number on which the die or jig has been designed. This gives a complete record in convenient form of all auxiliary appliances used in producing the work. These office information sheets are kept by this department and are filed away, a card index system, indexed according to order number and road, being used for this purpose.



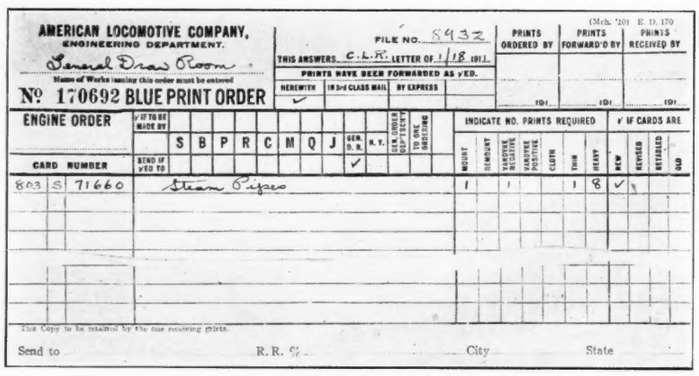
		80
	Draftsman	Smith.
	Schedule Delivery	4/10/1911
	Class	2-8-0
	Number of Engines	12
	Name of R. R.	C.P.R.
	Engine Order No.	S 783
GROUP	ENGINE DETAILS	SCHEDULE DATES
10	Ash Pan (Arrangement and Details)	
11	Axles, Driving	
11	Axles, Engine Truck	
11	Axles, Trailing	
12	Bell and Ringer	
13	Boilers—materials, layout and bills	
14	Boiler Details and Attachments	
15	Bolts, Studs and Keys	
16	Boxes, Driving, Bearings, Liners & Collars	
17	Boxes, Engine Truck Bearings, etc.	
17	Boxes, Trailing Bearings and Details	
18	Brackets, Steps, Painting, etc.	
GROUP	TENDER DETAILS	SCHEDULE DATES
11	Axles	
17	Boxes (Bearing, Wedge, Dust Guard, Lid)	
19	Brake Equipment	
54	Headlight; Shelf, Flag and Signal Fixtures	
54	Tank Capacity and Ownership, Plates	
62	Pilot, Bumper Knee, Rail Guard, Snow Plow	
63	Pipe Fittings, Train Line & Sig. Pipe Elbows	
80	Wheels, Tender, Centers and Tires	

Fig. 7. Schedule for Material Department



182 S 8390 — SHOWS PATTERNS MADE FOR: C S M I Br. C I — Slide Valve Cover — No. J

Fig. 8. Pattern Record Card



AMERICAN LOCOMOTIVE COMPANY, ENGINEERING DEPARTMENT. General Draw Room. Nº 170692 BLUE PRINT ORDER. FILE NO. 8932. THIS ANSWERS C.L.R. LETTER OF 1/18 1911. ENGINE ORDER. CARD NUMBER 803 S 71660. Steam Pipes. Send to ____ R. R. ____ City ____ State

Fig. 9. Blueprint Order Slip for Ordering Blueprints

Material Department

The material department in charge of an assistant engineer makes a record of all the material required on any order; everything ordered on the outside must be recorded in a special material book. This material book is a specially printed book resembling the previously mentioned card book and is arranged in the group order number with all the principal names of parts printed therein. Complete information for the purchasing department is there given. This information is obtained from the designing draftsman in various ways. Some, depending on the nature of their work, compile bills of material which are handed over to this department to be entered in the material book, while a large part of the information is obtained directly from the cards. The results are carefully checked over by the department, so that no omissions or duplications can be possible. On account of the large amount of material obtained on the outside for the boilers and tanks, there are special material bills prepared for these, which obviate the necessity of drawings for all these parts, for the material book usually orders by drawing number.

The material book is posted with the new material requirements that come in day by day, until the time allotted on the schedule is fulfilled; at this point from 75 to 80 per cent of the material has been entered, as a rule, but as the book is called for by the schedule it must be sent forward. Just prior to the "call" day, therefore, the necessary copies are made. The original is retained in the drafting-room; one copy goes to the purchasing department; one to the stores to check the supplies as they come in; and a third to the scheduling department. To handle the balance of the material which has not been entered in the material book, there are special "Additional Material Sheet" forms which are made out in triplicate as the further material information comes in. These are made out daily and sent to the different departments to which the material book copies have been forwarded. A clerk in each of these departments then fills in the missing information and returns the sheet to the material department. In this way the books are finally completed, the material department keeping a check on this operation throughout.

Pattern Department

A very complete record of patterns is kept in the drafting-room, special forms such as are shown in Fig. 8 being used to file the records away. When a pattern has been made for any particular order such as S 783, referred to in the figure, the card shown is made out recording that fact. Patterns are numbered in a precisely similar manner to the drawings, the group, etc., being the same. When a pattern is made, a card similar to the one shown is filled out; this shows the material of which it is made and also in the three vertical and horizontal columns, whether it can be lent and whether it is new, duplicated or reconstructed. Now supposing an order went through the Richmond works, R 812, which used the same slide valve cover. A clerk at Schenec-

tady, looking up his records, would see that this pattern had been used last at Schenectady on order S 783. Notification would then be sent by the pattern clerk both to the Schenectady local works and to the Richmond works, notifying the former that the pattern was required, and the latter that the pattern they needed could be obtained from Schenectady. The charge is then removed from S 783 to R 812 as shown. The Richmond and Schenectady works then communicate with each other and have the pattern shipped from Schenectady to Richmond. Should it so happen that the pattern was in use at Schenectady, word to that effect would be sent to Richmond and the latter works would then be required to make a new pattern. When this is done notice to that effect is sent to the pattern clerk at the general drafting-room who records a new pattern under the same number, on the same sheet, by another check mark in one of the nine squares. The next order coming in, which requires the same part would then have two pattern selections from which to choose. While this feature appears to be rather complicated, a little examination will show that it is remarkably simple.

Blueprint Department

When the elevation draftsman has finished with the newly made tracing, before it passes on to the die department, etc., a blueprint order form such as shown in Fig. 9 is attached to the tracing. This gives the tracing number, name and number of blueprints required. If it is not a new tracing but is already in the vault, the order form goes directly to the vault and the tracing is charged against the blueprint room. The time the order was received, the time it leaves, and the clerk filling the order, are marked on the form, which then goes with the tracing to the blueprint room. Here it is again inspected for any clerical omission such as signatures, etc., when it is given to a clerk who schedules it.

The blueprinting is done by piece-work in large electric printing machines. The system is so arranged that blueprints pass in a direct line from the printing machine to the washing machines and on through the dryer over an endless chain, and are deposited at the far end where they are sorted. When the last blueprint has been printed, a boy takes the tracing and order from the printing machine to the sorting table where the order is checked with the number of blueprints made; the blueprints then pass out to the party ordering them. This order form is made out in quadruple: one copy is kept by the party ordering; one comes back with the prints; a third is held by the blueprint department until the fourth, which has been returned with the prints, has been signed by the party ordering them. The delivery and receipt are thus automatically checked. Something like 1200 prints a day go through the blueprint department with practically no confusion.

The blueprint department also makes vandykes, one of which is sent to each of the works for every drawing made, so that each drawing office has a complete record.

Standardizing

A special department is devoted exclusively to standardizing the details of the locomotive. Until recently there was a special series of drawings devoted to this line of work called the "A" drawings, this letter being used in place of the "S" or "B," etc., employed in ordinary drawings. This system was found to be faulty in that a drawing once made and lettered "A" must always be considered as standard. This led to a lot of idle drawings for, as progress was made, the standards frequently changed. For that reason it was decided to drop the "A" standards and use the same lettering as on the ordinary drawings. The distinction made is that the drawing is marked "standard" below the title. By this system this standard may at any time be rescinded and the standard drawing reduced to the status of the ordinary drawing by cancelling the "standard" mark. All drawings are thus kept operative.

This department, in its work, would take a series of drawings on any particular part, group them and, so to speak, make composites, forming a uniformly varying series of articles to replace more or less unsystematic designs of similar pieces. Necessarily this could not be done with all parts, but a great many improvements have been instituted in this department and considerable saving as well as improvement in work can be traced thereto.

An assistant engineer and staff devote their full time to this work, and are constantly on the lookout for new details to be standardized. When any part has been standardized to their satisfaction, before being accepted as such, it must be passed upon by the standardization board; this standardization board is composed of all the engineers whose business it is to decide upon such subjects. If it meets with their approval, the drawing passes out as standard and must in all cases be used as such except where it conflicts with the contract specification.

Office Information Department

This department, in charge of an assistant engineer, has to deal with a lot of general office information such as the tabulation of data for ready reference, and data of insufficient importance to bring before the standardization board. While in a sense the standard and office information departments cover much the same work, there is a distinct line of demarkation. The office information department merely works out ideas that are thought advisable to follow, whereas the standard department gets out ideas that must be followed.

The office information sheets are made on M.C.B. standard letter-size tracing linen. These sheets are formed off into oblongs, eight on a sheet, the information being printed concisely in each of these oblongs. Prints are made from these tracings and the individual parts sent to the particular department to which the information is of the most value. These little tickets are mounted in a large frame placed up on the wall so that each draftsman may consult them constantly.

Another of the duties of the office information department is to get out a different type of office information, such, for example, as standard bell drawings or standard Westinghouse pumps. These are made on tracings, vandyked and positives made, these positives being waxed and given around to the different elevation men, who can make use of them as templets, for the purpose of locating the bell or pump, as the case may be, in some convenient place on the locomotive. They are drawn to the same scale for that purpose, and being waxed, can be used for this purpose as they are as transparent as linen.

In general, the work of this department is to compile such existing locomotive data as can be obtained, and as the designing engineer has constant need of. The office information department takes this information and arranges it in the most convenient form so that no unnecessary time will be lost on this score; briefly, it looks after such information as is considered of insufficient importance to submit to the standardization committee.

* * *

STORING JIGS AND FIXTURES

The storing away of heavy jigs and fixtures presents some difficulties. Most frequently one sees them left in a corner of the shop where they get dirty and dusty, and do not add to the attractiveness or neatness of the general appearance of the shop. In other cases they are pushed underneath the shelving on which the smaller jigs and tools are kept. In this case they are equally exposed to dust and dirt, although there is a semblance of order in the manner in which they are kept. A very neat way of storing these tools is used in the Schumacher & Boye shops, in Cincinnati, Ohio. A large wooden cabinet with doors is used, and the jigs and fixtures are kept in this when not in use. As it is rather difficult to push in and pull out heavy fixtures when they are stored in a narrow space between the shelves, small rollers are provided underneath the heaviest tools, so that they can be pushed in or pulled out with very little effort. This method of storing the jigs involves very small expense, but is a great convenience, and it looks neat.

* * *

Accidents will occur in the best regulated institutions, but this is no excuse for tempting Providence by being reckless.

AIR COMPRESSOR DESIGN*

THE INTERCOOLER—ITS RELATION TO STAGE COMPRESSION

By J. WILLIAM JONES†

It is a well-known fact that in compressing air a great amount of heat is generated due to the friction of the molecules composing the air, which are being crowded into a smaller space. In compressing air to 100 pounds gage pressure, the final temperature, assuming the compression to be adiabatic, would be about 485 degrees F. The effect of this constant increase in temperature is to tend to expand the air under compression to a larger volume, thus necessitating a corresponding increase of work to compress this apparently increased volume. After the compressed air has been discharged into the receiver or pipe line the temperature rapidly falls to that of the surrounding atmosphere and the energy due to the heat generated during compression is lost. It therefore follows that in compressing air to any great extent, a large amount of work is expended due to temperature conditions and the only method of reducing to a minimum the amount of work lost is to cool the air during the period of compression. In theory, the air should be kept at a constant temperature during the period of compression; but the attainment of this is a practical impossibility in compressors of the present day.

In modern compressor engineering practice, the work is divided equally between two or more stages, the number of stages depending on the final air pressure required and the employment of an "intercooler" between the different stages to reduce the temperature of the compressed air to the normal between the stages. In effect, this arrangement is equivalent to doing all the work in a single cylinder if it were possible to stop the piston at a certain point of the stroke, reduce the temperature of the air already partially compressed to that of the surrounding atmosphere, at the same time moving the piston forward just fast enough to keep the pressure constant, and then start the piston again and continue the compression to the desired pressure.

A sectional view of an intercooler built in accordance with modern practice is shown in Fig. 1. This intercooler consists of a long shell of cylindrical shape containing a nest of tubes through which cold water is circulated. The air enters at one end of the shell from the low-pressure cylinder at a high temperature, passes around and between the nest of tubes and enters the high-pressure cylinder at the other end at a greatly reduced temperature. This cooler is placed immediately above or below the cylinders in order to secure the shortest connections possible, the air remaining in these connections being denied the cooling effect of either the cooler nest or the water jackets of the cylinders. The tubes constituting the nest are expanded at each end into steel or brass plates which are bolted directly to the water heads. Some advantages are claimed for brass tubes because of their higher conductivity; but these advantages are not of sufficient value to warrant their extra cost. Galvanized iron pipes have been found very efficient, attributable to the rough surface which these pipes possess.

As the intercooler is primarily the medium through which the saving in power is to be derived, it is obvious that unless proper attention is given to all its details the desired effect may not be realized. The essential points to be considered in the design of an intercooler are: Cooling surface, efficient water circulation, volume of cooler, proper deflection of the air around and between the tubes, convenient drains, and accessibility to the tubes.

The amount of cooling surface required is generally based on the quantity of "free air" compressed per minute. As the thermal condition of the air subject to compression is dependent on the final pressure, it is evident that the amount of cooling surface in relation to the free air capacity of the compressor varies with the discharge pressure. Theoretically, the cooler should have a sufficient amount of cooling surface to reduce the temperature of the air between the two stages to the same point at which it was first taken into the low-pressure air cylinder. In practical working conditions, however, it will be found that the majority of coolers fail to accomplish this result and a reduction to within 5 or 10 degrees of the original is usually conceded to be good practice.

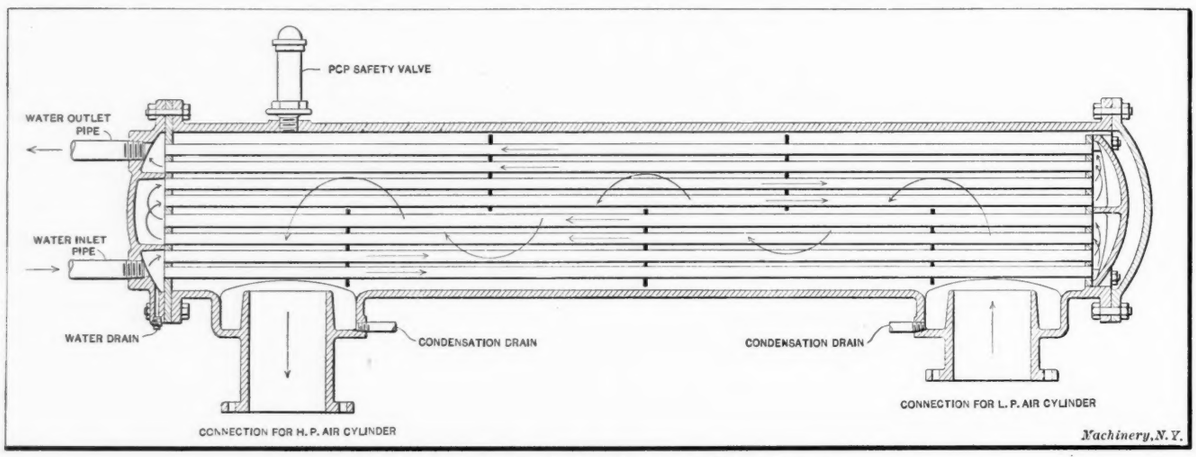


Fig. 1. Intercooler built in Accordance with Modern Practice

An efficient water circulation is a matter which requires some thought and consideration, as the water is the agent which absorbs the heat units. A cooler may be well designed in every other respect, yet if a proper circulation of the water is disregarded it may offset all the other efficiencies. The flow of the water should be through unrestricted pipes at such a velocity that the maximum number of thermal units is absorbed and carried away by the water; the flow of the water should also be directed properly in relation to the flow of the air. The best practice is to make the general flow of the water opposite to that of the air; the hottest air will then come in contact with that portion of the tubes containing the warmest water, and as the air is gradually cooled it comes in contact with the cooler portion of the cooling nest. In the intercooler shown in Fig. 1, the water circulates the entire length of the cooling nest four times. Entering through the lower pipe attached to the outside water head, the water being deflected by the partitions in the heads, circulates as indicated by the arrows shown on the small pipes. This circulation system is in accordance with the laws of thermodynamics; the hot water gradually finds its way to a higher level until it is finally discharged through the upper pipe leading from the outside water head.

*For additional information on this and kindred subjects previously published in MACHINERY, see "Horsepower Required to Compress Air," January, 1911, engineering edition; "Horsepower Required to Compress Air," December, 1910, engineering edition (and other articles there referred to). See also "Compressed Air, for Stiffening Beams, Struts and Flat Surfaces," October, 1910; "New Idea in Air Compression," September, 1908, engineering edition; "General Electric Co.'s Centrifugal Air Compressors," December, 1907; "Standards of Efficiency in Compressed Air Practice—The Air Compressor as an Air Meter," June, 1907, engineering edition; "Leakage in Compressed Air Plants," January, 1907, engineering edition; "Separator for Water in Compressed Air," January, 1907, engineering edition; "Air Compressor With Minimum Clearance Space," May, 1905, engineering edition; "Hydraulic Compression of Air," September, 1902; "A Novel Air Compressor," September, 1899.

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The cooler should have ample volume for the air, in its passage from the low- to the high-pressure cylinder, to obtain the best results. It is good practice to make the cooler of such cross-section as to readily admit a free passage of the air after the "baffle plates" have been placed; and then having determined this area, make the cooler of such length as is required to obtain the necessary amount of cooling surface. It is obvious that a cooler of large volume has advantages over one of smaller volume, even if the cooling surfaces be equal, because the air, in passing from the low to the high-pressure air cylinder, has a longer period of contact with the cooling tubes in the cooler which has the greater volume.

The compressed air should be well deflected in its course through the cooler. This result is obtained by placing several "baffle plates" in the cooler, as shown in the illustration, which deflect the air alternately towards each side, thus bringing the air into contact with all parts of the cooling nest.

There are several small details of intercooler construction which should not be neglected, such as proper drains for drawing off the condensation of the air. The moisture of the air is in the form of a vapor, which when rapidly cooled, is condensed, and should be drawn off at stated intervals. Convenient drain connections should also be provided for draining the cooling nest in case of a suspension of the operations of the compressor at any time when freezing is liable to occur. It will be noticed that the cooler shown in Fig. 1 is so constructed that the entire nest of tubes can be withdrawn at any time for examination or cleaning purposes. This is an important feature, as it enables a defective or leaky tube to be replaced with very little difficulty.

The Theory of Stage Compression with Intercooling

The theory of compound or stage compression is very readily understood. In the first paragraph of this article a statement was made relating to the heat produced in the compression of air. For all pressures above 70 pounds per square inch, it is generally conceded that compound or stage compression should be employed. The heat of compression increases with the pressure; therefore, the higher the pressure the more difficult it is to reduce the temperature to a point enabling efficient compression conditions and proper lubrication of the air cylinders. In compressing air to 100 pounds terminal gage pressure in a single stage compressor, the final temperature of the air would be about 485 degrees F., as before mentioned. Some of this heat would be absorbed by the cylinder walls; yet the final temperature would remain too high to insure efficient compression conditions or proper lubrication. The adoption of stage compression with intercooling between the stages, although introduced some thirty to forty years ago, has been neglected by compressor builders until within the last decade. At the present time stage compression is almost universally employed for all pressures above 70 pounds, unless the compressor is of such small size as to make compounding an uncommercial proposition.

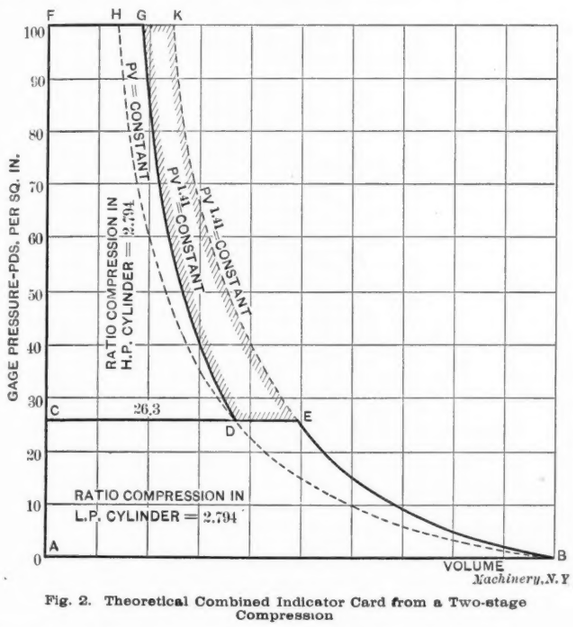


Fig. 2. Theoretical Combined Indicator Card from a Two-stage Compression

In Fig. 2 is shown a theoretical combined indicator diagram from a two-stage compressor. In this diagram it is assumed that the compression follows the adiabatic curve in both high- and low-pressure cylinders with perfect intercooling between the two stages. The horizontal lines *A B* and *C D* represent respectively the volumes of the low- and high-pressure air cylinders, drawn to the same scale. The vertical line *A C F* on this diagram will represent pressures to some designated scale. The adiabatic curve *B E K* represents the relation between pressure and volume for any position of the piston, assuming that there is no intercooler employed and that no heat radiates through the cylinder walls. In other words, this curve is the one which compression would theoretically follow in a single cylinder with no intercooling. In this curve the product $P V^{1.41*}$ is constant, *P* and *V* representing pressure and volume respectively. On the other hand the isothermal curve *B D H* shows the relation between pressure and volume providing the temperature of the air under compression could be kept constant so that the product *P V* would also be constant.

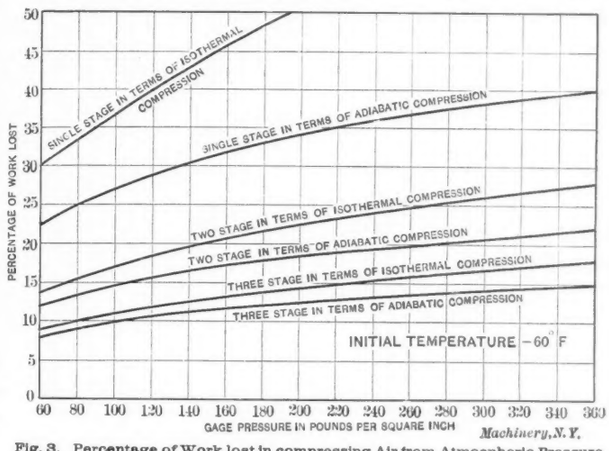


Fig. 3. Percentage of Work lost in compressing Air from Atmospheric Pressure to Various Gage Pressures, by Simple and Stage Compression

Air taken into the low-pressure air cylinder at zero gage pressure, is compressed along the adiabatic curve *B E* until at the point *E* it attains a pressure of 26.3 pounds, equal to that of the intercooler, which allows the discharge valves to open and the air to pass into the cooler. In the intercooler the volume of a definite weight of the air is reduced from *C E* to *C D* so that the volume entering the high-pressure cylinder is less to the extent of *D E* which is to the same scale as *C D* and *A B*. This means that the given weight of air represented by the volume *C E* at a gage pressure of 26.3 pounds, when cooled to the same temperature at which it was originally taken into the low-pressure air cylinder will be reduced in volume to *C D* providing the pressure of 26.3 pounds remains constant. The air taken into the high-pressure air cylinder at 26.3 pounds is compressed along the adiabatic curve *D G*. At the point *G* the high-pressure discharge valves open, and the air is discharged into the receiver at the desired gage pressure of 100 pounds. The shaded portion represents the saving effected by the intercooler.

Assuming that a volume of 1000 cubic feet of free air per minute is to be compressed to a gage pressure of 100 pounds with perfect intercooling between the stages, 153 horsepower is required. Compressing this same amount of air in the same time in a single stage requires an expenditure of 180 horsepower, or an excess of 27 horsepower over the amount required in two stage compression. This excess is equivalent to a saving of about 15 per cent in two stage compression, which can be attributed directly to the intercooler. The actual saving, however, would fall somewhat below the above percentage due to the fact that there are necessarily more frictional losses in the two stage machine than in one having a single cylinder; also the intercooler cannot be relied upon

* The exponent 1.41 is the ratio between the specific heat of air at constant pressure and at constant volume.

to reduce the temperature of the air between the stages to the normal in all cases. It is safe to state, however, that the saving in compressing to 100 pounds gage pressure would equal or exceed 10 per cent in a well-designed compressor. At higher pressures, the saving in power is much more marked.

In Fig. 3, curves have been plotted which show the loss of work due to heat in compressing air to various pressures in one, two, and three stages, assuming an initial temperature of 60 degrees F. in all cylinders, which is equivalent to perfect intercooling in the curves for stage compression. These curves show very readily the advantages of two stage compression over single stage.

As previously stated, the intercooler is primarily the medium on which the principle of compound compression is based, yet the saving due to the reduction in temperature between the stages does not constitute all the advantages of stage compression. The maximum temperature in each cylinder is reduced to a point where the heat can be more thoroughly drawn off by the water jackets surrounding the cylinder walls; also, the lower temperature in the cylinders is less liable to affect a good oil, thus insuring good lubrication of the pistons, valves, etc., with easier running conditions, less wear and longer life.

Increased Volumetric Efficiency

The volumetric efficiency of a compound compressor is obviously greater than that of one having a single cylinder. The compressed air remaining in the clearance space of the low-pressure cylinder being at a much lower pressure, requires less movement of the piston on the return stroke before the air in the clearance space is expanded to a pressure equal to that of the surrounding atmosphere, which permits an opening of the air inlet valve. As free air is taken into the low pressure cylinder only, the high-pressure cylinder bears no relation to volumetric efficiency, for it follows that all air taken into the low-pressure cylinder must necessarily pass through the high-pressure cylinder unless there is some leakage present. The reduced temperature conditions in the low-pressure cylinder also causes less heating of the intake air when it comes in contact with the cylinder heads and walls, which results in obtaining a denser volume of air at each stroke of the piston, with a corresponding increase of volumetric capacity.

In addition to the advantages already mentioned, the maximum stresses in a compound compressor are reduced to about 55 per cent of what they would be in a single stage machine compressing to the same pressure. In a single stage compressor having a cylinder of 20 inches diameter compressing to 100 pounds terminal gage pressure, the piston starts against no load at the beginning of the stroke and at the end of the stroke meets a maximum resistance of 31,416 pounds. Assuming the compressor to be running at a speed of 150 revolutions per minute, the piston meets this resistance and its release 300 times every minute. On the other hand, a two stage machine compressing to this same pressure with the intake or low-pressure cylinder of the same size as the above-mentioned single stage cylinder, would encounter a maximum pressure of only 9424 pounds when working against a cooler pressure of approximately 30 pounds. In order to divide the load equally, the high-pressure piston area would be proportioned to the low-pressure piston area in the same ratio as the square roots of their absolute pressures. That is

High-pressure area : 314.16 : : $\sqrt{14.7}$: $\sqrt{114.7}$.

Or high-pressure area = 112.5 square inches.

The area 112.5 square inches is equivalent to a high-pressure cylinder diameter of about 12 inches. Compressing from 30 to 100 pounds in the high-pressure cylinder gives a maximum unbalanced pressure of 70 pounds, which is equal to a maximum load of 7917 pounds to be met in this cylinder. The total maximum resistance in both high- and low-pressure cylinders, is therefore, 9424 pounds plus 7917 pounds, or 17,341 pounds, which is only about 55 per cent of that in the single stage compressor.

* * *

MUELLER TESTING STAND

The accompanying half-tone Fig. 1 shows an interesting testing stand used by the Mueller Machine Tool Co., Cincinnati, Ohio, for varying the speed while testing the radial drills built by the company, when completely assembled and ready for shipment. As will be seen from the illustration, the apparatus is portable and can be easily moved to any machine on the assembling floor. The power for driving the radial drill while testing is derived from a motor placed on the base, and transmitted from the motor to a gear-box at the top of the testing stand, by means of a belt as shown.

With the gear-box at the top of the testing stand it is possible to obtain six different speeds, thus making it convenient to test the machine at any required number of revolutions of the spindle. The gear-box is of the same type as that used on the regular gear-driven radial drill presses built by the company, the construction of which is shown in the half-tone illustration Fig. 2, and also indicated in the line engraving Fig. 3. In this latter engraving *A* is the driving shaft, *B* is the intermediate shaft, and *C* the shaft from which, by intermediate gearing, the spindle of the machine is driven. On shaft *A* is placed a clutch which can engage either the gear to the right or that to the left, thus giving two speeds to shaft *B*. The gears on shaft *C* are sliding gears and can be brought in mesh, respectively, with either one of the three gears *D*, *E* and *F* on the intermediate shaft *B*, thus giving six changes of speed to the spindle. The most interesting part of the construction of the gear-box is the clutch on shaft *A*, which is of an exceedingly simple construction. The general principle upon which it operates is shown in Fig. 4. It will be seen that it consists of a sliding collar operated by a forked lever from the outside of the gear-box. On each side of the collar is a taper projec-

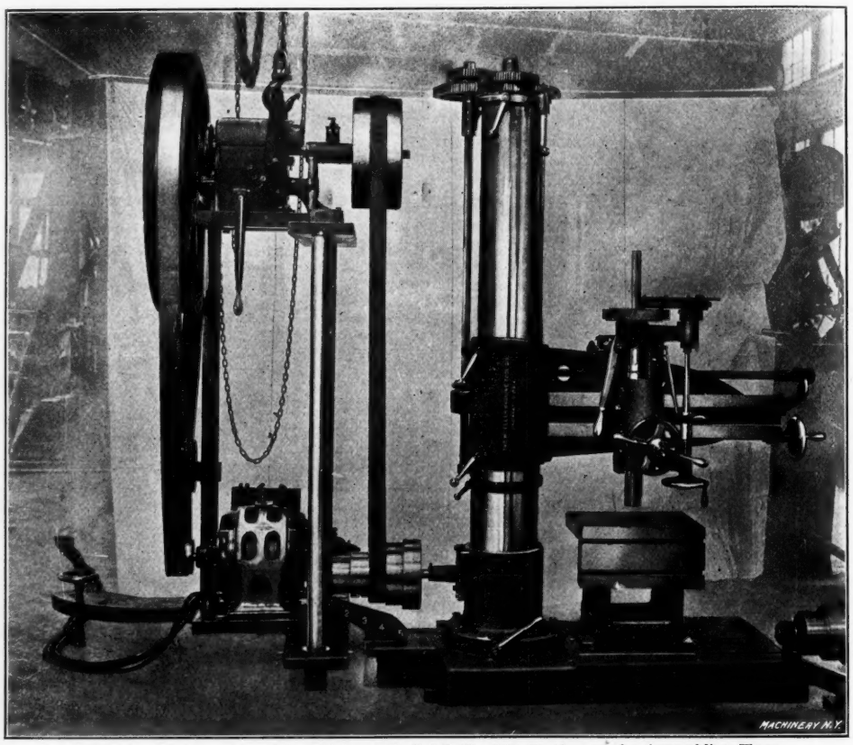


Fig. 1. Testing Stand used for Driving a Radial Drill while Testing on the Assembling Floor

tion which, when the collar slides either to the right or left, enters into a correspondingly tapered slot in the friction ring, thus expanding the latter and forcing it to grip on

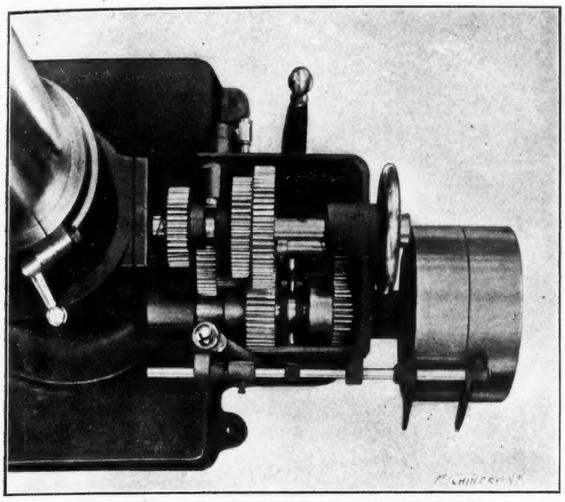


Fig. 2. View of the Gear-box used on Testing Stand

the inside of the gear to be driven. When compared with a great many other constructions of similar kinds, it will be seen that this clutch is unique in its simplicity, and it will, therefore, undoubtedly be of interest to mechanics who are not familiar with this type of clutch.

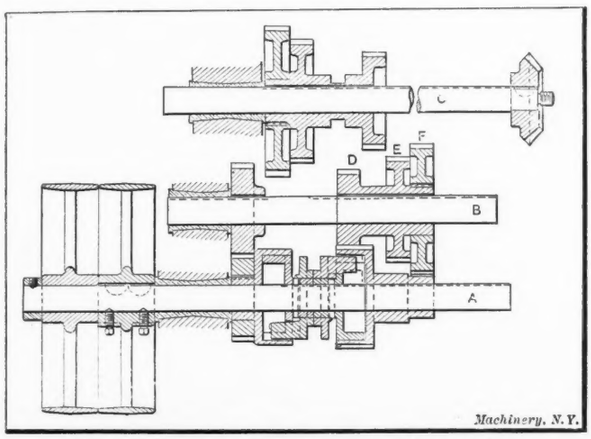


Fig. 3. Arrangement of Gears in Gear-box shown in Fig. 2

Referring again to the testing stand, it will be noticed that it is provided with leveling adjustment; so that it can always be placed in proper position relative to the machine in connection with which it is to be used. It is supported at three points, and the supporting point to the left consists of a

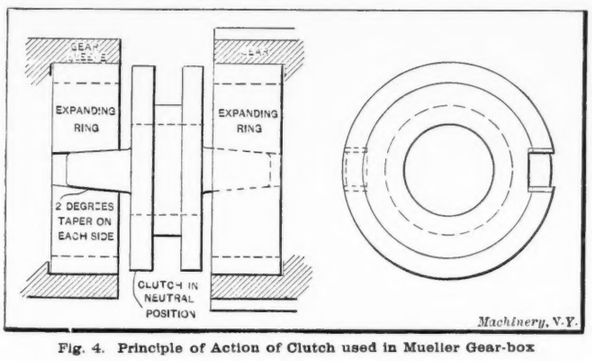


Fig. 4. Principle of Action of Clutch used in Mueller Gear-box

screw provided with a handwheel so as to make this support adjustable. The convenience with which this testing stand can be moved from machine to machine makes it a very economical and useful device, and makes it possible to test the assembled machines in any location that they may occupy on the assembling floor.

GENERAL APPLICATION OF SPRING CHUCKS TO LATHES

The oldest and most indispensable machine tool—the lathe—has, within recent years, received much attention at the hands of the mechanical engineer, until to-day the number of different designs probably exceeds that of all other machine tools combined; but notwithstanding this fact the designer of modern lathes seems to have given little attention to the means for holding the work in a standard engine lathe. Lathes designed to handle bar work exclusively, are, as a rule, provided with efficient chucking facilities, but on the other hand, standard engine lathes and even so-called "chucking" lathes are rarely provided with better means for holding work than two-, three- or four-jawed chucks. These are, of course, indispensable for holding some classes of work, such as pieces of irregular shape, and in many cases for first operations. For practically all second operations, regardless of the shape of the piece, and frequently all operations when the shape of the piece permits, split chucks could be used at a great saving of time, if the lathes were suitably designed for the use of

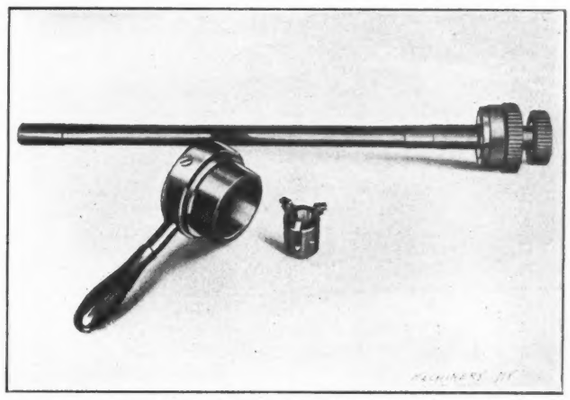


Fig. 1. Muehlmatt Mechanical Opening and Closing Spring Chuck Operator

these chucks and if proper means were provided for operating the chucks.

By "split chucks," the ordinary steel split collet sometimes found in the tool-room is not alone referred to, but chucks of any size, either expanding or contracting, made of steel, cast iron or bronze, as the nature of the work demands, and suitable for holding work up to the full capacity of the ma-

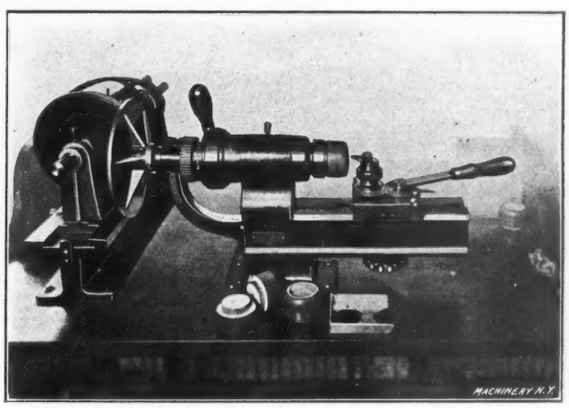


Fig. 2. Special Wood-turning Lathe with Spring Chuck and Operator

chine. Split chucks have been in universal use in the watchmaking industry for over a quarter of a century. Small precision lathes have been equipped with split chucks for many years, and more recently a few of the leading lathe builders have placed what are known as "tool-room lathes" on the market, equipped with chucks of this type. While the application of split chucks to the engine lathe is doing much toward educating the machinist to their use, the average mechanic still considers such chucks as belonging to precision work.

For the past eighteen years Adolph Muehlmatt, Cincinnati, Ohio, has been engaged in the manufacture of a class of tools

and devices demanding rapid chucking facilities as essential to profitable production, so that considerable time and attention has been given to the problem of chucking work, and experience has demonstrated that in many instances cast-iron split chucks answer every purpose as well as the tool-steel or casehardened chuck. These cast-iron chucks are produced at a low cost, and when used on second-operation work their life is indefinite. In the Muehlmatt shops, a number of such chucks have been used on from 5000 to 10,000 operations without showing signs of wear. On a Jones & Lamson flat turret lathe, used as a chucking machine exclusively, all contracting chucks above 1-inch bore are made of cast iron, while the expanding chucks for the same machine are generally made of tool steel and hardened, if under 2 inches in diameter. Cast iron is used for sizes above 2 inches. Probably because of the lack of experience and investigation, few mechanics are ready to grant that cast-iron split chucks will hold the work securely under all conditions and that the life of such chucks can be anything but short. A little research, however, will show this principle in use in an endless number of mechanical devices, working satisfactorily under conditions not nearly so favorable as in the case under consideration. Countershafts where the power consumed by a machine is transmitted through cast-iron friction clutches, offer a good example.

After the superiority of the split chuck for holding many classes of work in connection with machining operations had been proved, the problem of devising mechanical means for operating this type of chuck had to be solved. At first the chucks were operated and closed in the ordinary way, that is,

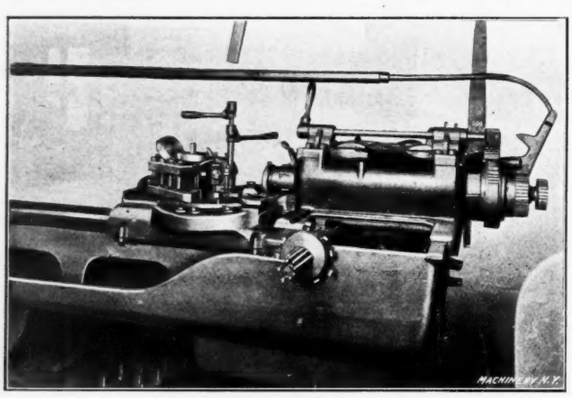


Fig. 3. Jones & Lamson Turret Lathe equipped with Muehlmatt Chuck Operator

by stopping the lathe and throwing in the back-gear to lock the spindle; the quill was then unscrewed, thus opening the chuck, when the work would be removed, another piece put into the chuck, and the operations referred to repeated inversely. Under these conditions the time consumed in chucking would frequently exceed the time required for tooling, though, at that, it was an improvement over the use of the ordinary machine chuck.

In order to handle work with greater facility, a device was needed that would deliver the maximum of power required with little effort on the part of the operator; it had also to be applicable to lathes of various classes with the least possible disturbance to the design, and to be so simple in construction that it could be built at a comparatively low cost. Devices already in use for automatically operating chucks on screw machines or turret lathes, though answering very well their specific purposes, were rejected, due to limitations that would not permit their universal use on the standard engine lathe for chucking purposes.

The requirements referred to in the foregoing have been met by the mechanical opening and closing chuck illustrated in Fig. 1, which in its application to such machines as are suited to the use of spring chucks, has proved so satisfactory that spring chucks are now used in the Muehlmatt shops for all lathe operations, except the first, and in many instances for all operations including the first. While some bronze castings, brass tubing and rod stock is machined, the greater part of the work consists of iron castings that are finished all over. All work is of the interchangeable type, jigs and special fixtures being used throughout; hence the lathe work has to be accurate, and this accuracy has been easily maintained. Since the time required for chucking is a negligible factor, in not a few instances, where but two operations are required, a saving of time is effected by chucking the piece twice, rather than revolving the turret for each operation. Engine lathes equipped with spring chucks and a chuck operator could, of course, be used to advantage in such cases instead of the chucking lathe.

The time consumed in chucking work varies from 5 to 20 seconds, depending upon the size and form of the work. On

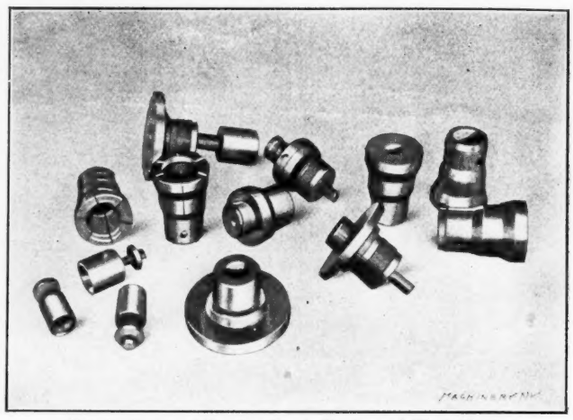


Fig. 4. Group of Chucks, Chuck Blanks and Work Ejectors

the Jones & Lamson flat turret lathe, as many as 1000 pieces are chucked in a ten-hour working day. On a 14-inch Hendey-Norton lathe, the number of pieces chucked quite frequently exceeds 1500 per day, while on the friction-driven bench lathe, illustrated in Fig. 2, from 3000 to 4000 pieces are handled daily. This lathe was built in the Muehlmatt shops for a special class of wood turning. It is, of course, understood that these figures apply to rapid tooling operations, and the point we wish to emphasize is that little time is wasted in chucking the work; this applies to all classes of work whether large or small. It is rarely necessary to stop the spindle of the machine during a chucking operation, the operator wearing gloves to protect his hands from burns and cuts while chucking.

For some classes of work, ejectors are placed within the chuck to discharge the work when the chuck is opened. These ejectors also keep the chuck slots and the work seats free

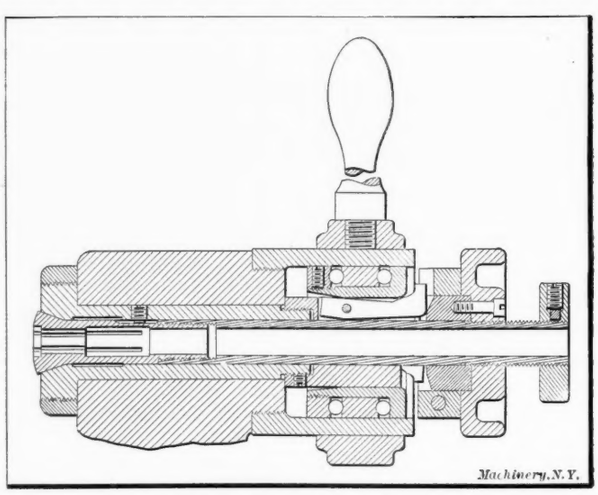


Fig. 5. Sectional View of Chuck and Operator

from chips when boring open holes. When ejectors cannot be used to advantage, a knock-out rod is substituted for discharging work that cannot be grasped by the hand.

Lest this system be confounded with that in vogue in tool-room practice, where split chucks are used to some extent and where quite often—for good reasons or otherwise—a

mincing cut at the slowest speed and finest feed is run on a piece of drill rod held in a split chuck, let us emphasize the fact that the heaviest cut that the tool can take care of or that the case justifies is practicable with a properly-designed spring chuck. This system was developed as a manufacturing proposition for the rapid and accurate production of duplicate parts with the smallest expenditure of effort on the part of the operator.

The standard type of cast-iron contracting chuck used on the Jones & Lamson flat turret lathe, measures 2¾ inches in

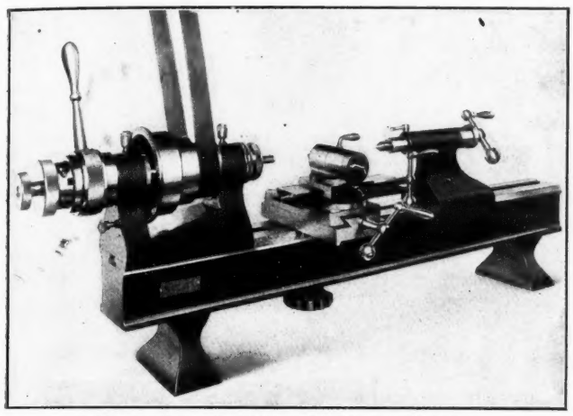


Fig. 6. Chuck Operator applied to a Bench Lathe

diameter through the section back of the closing angle, and the thickness of the wall through the split section measures ½ inch. The chuck protrudes from the end of the spindle but 11/16 inch. A chuck of these dimensions is sufficiently resilient for all purposes, yet under these conditions the chuck and the work held by it practically becomes a component part of the machine spindle. Chattering is eliminated, and a cutting tool working under such favorable conditions does not become dull so quickly. A Jones & Lamson machine equipped with one of these chucks is shown in Fig. 3. In this particular case, the lever for the chuck-operating mechanism is located just above the chuck, connection being made by a shaft and sector gears as shown. In Fig. 4, a group of chucks, chuck blanks, and work ejectors used on this machine are shown.

With the spring chuck system, the part of the work gripped by the chuck is generally well within the spindle of the ma-

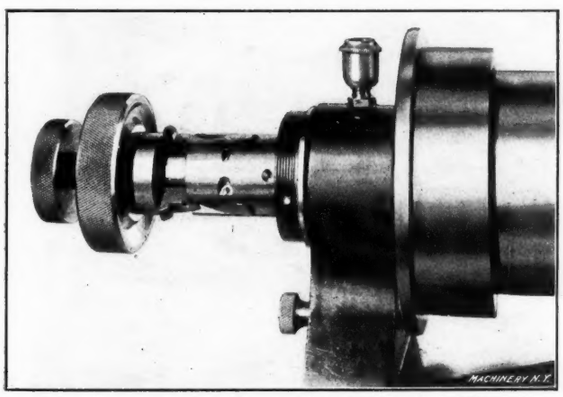


Fig. 7. Operator Housing Removed to show Position of Fingers when Chuck is Closed

chine, which is much better than the common practice of holding the work in a three- or four-jawed chuck, where the distance from the end of the lathe spindle to the work-holding jaws measures anywhere from 4 inches to 10 inches. The jaws, as a rule, are also more or less strained and frequently do not have a square contact with the work.

Few favorable conditions exist for the general adoption of spring chucks, as the machine tool designers have been so deeply absorbed in all-geared heads, quick-change feed boxes, etc., that the problem of holding the work has, to a great extent, been left to the purchaser to solve. Few of the older types of lathes are suitably designed to receive spring chucks and their adjunct—the chuck operator; at least, not so that the fullest benefit may be derived from their use. Two different types of machines were found suited to the equipment illustrated herewith, with practically no alterations to their original design. Briefly the component parts of the Muehlmatt mechanical opening and closing chuck, which is shown in section in Fig. 5, are simply a plurality of cylinders working within each other, whose cooperative members are coupled together in a simple yet positive manner. The chuck operator forms a self-contained, independent unit, that, on suitably-designed machines, can be applied or removed as easily and as quickly as a machine chuck and should be interchangeable with any number of lathes of the same type. One of these operators is shown applied to a bench lathe in Fig. 6, and Figs. 7 and 8 are detailed views of the lathe headstock with

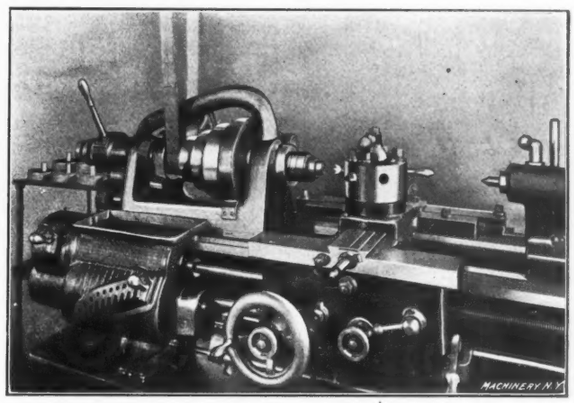


Fig. 9. Spring Chuck and Operator applied to Hendey-Norton Lathe

the operating lever and housing removed. Fig. 7 illustrates the position of the operating fingers when the chuck is closed, and Fig. 8 their position when the chuck is open.

In the matter of drives and feeds, the lathe has been developed to a high degree, and now the efforts of the designer should be centered on the features that, from a logical point of view, should be the most important in a metal-turning machine, namely, the spindle and its accessories for holding the work.

The work-holding capacity of a lathe instead of being described as, for instance, a 16-inch by 6-foot size, will doubtless at some future time be referred to as a 2-inch by 16-inch by

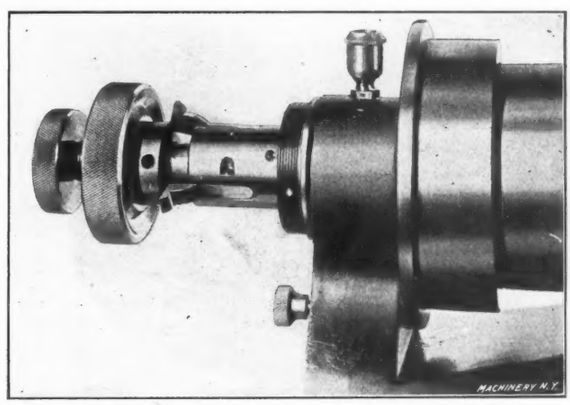


Fig. 8. Position of Fingers whep Chuck is Open

6-foot machine, the first figure standing for the spindle capacity of the lathe. We see no reason why a machine, of say, 16-inch swing, should not be equipped with chucking facilities that would enable it to handle certain classes of work up to that diameter through the spindle. For faceplate work, work that has to be turned between centers, and frequently first operations and pieces of unsuitable shape for the split chuck, the lathe as at present developed leaves little to be desired. This, however, represents but one division and probably the minor one of the work that a modern lathe should be capable of handling.

The means for holding a large part of the work that should

come within the scope of the engine lathe has so far remained largely undeveloped. This division embraces, besides an endless variety of castings and forgings, all tube and rod work up to the capacity of the spindle of the machine. Practically all of this work is handled now in a crude, awkward and time-wasting manner on the engine lathe. This, in many cases, leads to the installation of special or single-purpose machines, which is a justifiable course when sufficient work is at hand to run such machines to their capacity—idle machines do not produce dividends.

* * *

HOLLOW-HANDLE CUTLERY

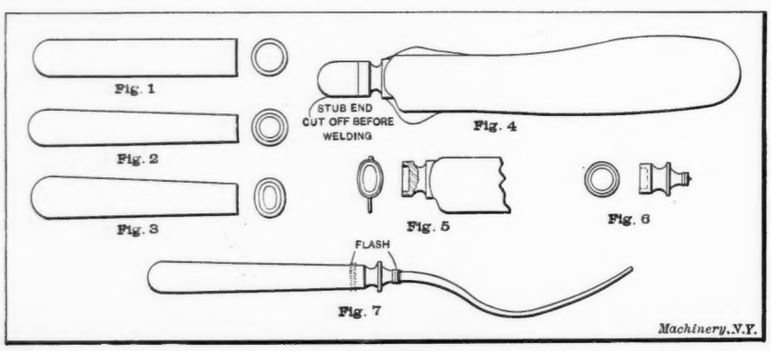
By ROBERT S BROWN*

The mechanic with his instinctive realization of the due relation between weight and size, is immediately struck with the lightness of the all-metal knives and forks with large, comfortable-feeling handles. A simple test for center of gravity, balancing one knife over the edge of another will show by the location of this balancing point that the handle must be hollow, although there is nothing in the outward appearance to prove this or indicate how the job is done. A solid-handle knife will perhaps balance an inch back on the handle from the bolster while the hollow-handle center of gravity moves forward out on the blade.

These light hollow handles which save stock and yet fill the hand, were formerly made in the same manner as the silver ones are still, with a seam all around, joining two shells like the halves of a pea pod, and also welded to the stub tang. This involves joints approximately 8½ inches long, which must be perfectly welded or there follows a leakage of dish water into the interior of the handle which will condemn it.

A later method of making these steel handles gives a welding surface less than 1½ inch long. This consists in drawing up a steel shell, Fig. 1, from a flat circular blank, and is done in several operations with inter-annealing in the well-known manner. The rough end of the handle is then trimmed with a wheel cutter. Following is the tapering of the shell in a Goodyear swaging machine to the shape shown in Fig. 2, then ovalling it into the exact contour of the finished handle, Fig. 3; this last is done in a press. The finished handle is also shown at *A*, in the halftone Fig. 8. This method is employed by the American Cutlery Co., of Chicago.

The blade shown in Fig. 4, has in the meantime been rolled in the automatic rolling mill illustrated in the New Machinery and Tools department of the August, 1910, number of



Figs. 1 to 3. Hollow Handle in Successive Stages of Production. Fig. 4. Knife Blank after the Drop-forging and Rolling Operations. Fig. 5. End of Knife Blank after Stub is cut off and End upset. Fig. 6. Bolster for Fork as it comes from Screw Machine before Ovalling. Fig. 7. Welded Fork, showing Flash at the Two Joints

MACHINERY, after having first been drop-forged from the solid round stock as shown at *B*, Fig. 8. *C* in this same figure shows the blade at the completion of the rolling operation. After trimming the blade and flashing, the tang beyond the bolster is chambered out in an upsetting machine, to the shape indicated in Fig. 5. The object of this is to provide a welding surface of the same sectional area as the handle, so that both will come to a sticking heat at the same instant and neither will be overheated.

On forks, the same result is arrived at in a little different manner; the portion with the tines may be rolled as the knife blades are. The handle is the same as the knife handle, but the bolster is a separate piece. This is a simple screw machine job turned with the chamber above mentioned in one end, as shown in Fig. 6, and at *D*, Fig. 8, and then ovaled by pressure. It is welded first to the tine portion as at *E*, Fig. 8, and then to the handle. As electric welding unites dissimilar metals, it is practical to use the non-ferrous metal alloys joined to the steel, and a choice of steel handles say, with German silver blades or tines is feasible.

Differentiating between the rolling and the hammering of the blades, the former is now generally preferred. Small pieces of coal from the fire which may adhere to the heated blade are more or less imbedded in the steel by the hammering process of drawing out or plating. These become an aggrava-

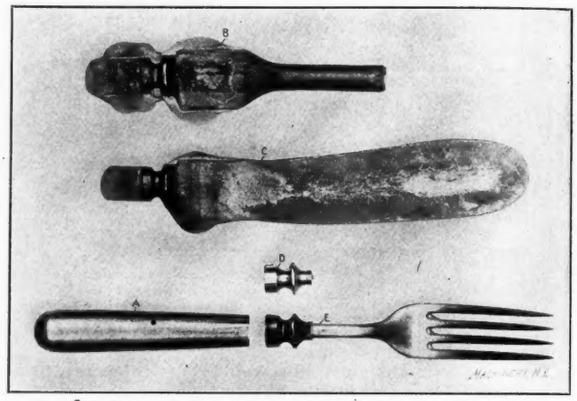


Fig. 8. Details of Knife and Fork in Different Stages of Manufacture

tion later showing as spots or pits in the blade when ground; the blades so spotted must be re-ground to take out the defects. In rolling with water running over the dies this spotting trouble does not appear and the thickness of the blades is constant. These features conduce to uniformity in the mechanical grinding now generally practiced.

There is but a slight flash ringing the welded joints indicated in Fig. 7 between blade and handle and handle and tines, and this, with the seamless process of smooth handle construction, makes polishing an easy matter there.

* * *

An interesting method for measuring the area of diagrams, or of sections of a map, is referred to in a recent issue of *Industritidningen Norden*. The diagram or map is drawn carefully to scale on a piece of plain drawing paper, preferably of high quality and of hard surface so as to be of uniform texture throughout. Then a unit area is drawn to scale on the same paper, this area corresponding to one square inch, one square foot, one acre, one square mile, or whatever the unit area of the diagram or scale of the map may be. This unit area is then carefully cut out and the piece of paper representing it weighed on a sensitive laboratory scale. The diagram to be measured is also cut out and weighed. In this manner a fairly accurate expression of the area can be obtained by dividing the weight of the total diagram or area to be measured by the weight of the unit area. A still higher degree of accuracy can be obtained by drawing to scale an area representing, say, ten times the unit area, and weighing a piece of paper corresponding to this larger area. The weight of this, divided by ten, is then the unit measure. It is stated tnat considerable accuracy has been obtained by employing this method.

* * *

Radioro is the name of a new alloy which is claimed to have the unfading yellow of gold, the hardness of hardened steel and to be unaffected by the atmosphere or ordinary acids. It is predicted that it will be used for household utensils, heavy machinery, armor, jewelry, and many other purposes.

*Secretary, New Britain Machine Co., New Britain, Conn.

DATA FOR FLUTING AND RELIEVING TWIST DRILLS

When making twist drills in the tool-room of the ordinary shop, one of the questions which the toolmaker must settle is that of the thickness of the point or web of the drill. He must also settle upon the width of the land back of the cutting edge on the cylindrical part that is left when relieving the drill. The latter question may not be of such great importance, but the former constitutes one of the vital points in twist drill making. The form of the flute or groove is, of course, also of the greatest importance, as it is required that the cutting edge of the drill should be practically a straight line; that is, the form of the flute should be such that the intersection between it and a plane making a 59-degree angle with the axis of the drill—the angle to which the drill is ground—will be a straight line. Cutters which will mill a flute having the required form are available in the market; but the toolmaker or tool designer may be called upon to produce cutters for this purpose occasionally in large plants making, in the shop tool-room, a considerable number of the tools required. In the accompanying table, therefore, are given dimensions for a satisfactory line of drill grooving cutters. The dimensions are calculated according to the following formulas:

$$W = 0.8\,D$$
$$A = 0.475\,D$$
$$R = 0.675\,D$$
$$r = 0.525\,D$$

in which W = width of cutter,
D = diameter of drill to be fluted,
r = small radius of cutter form (see illustration),
R = large radius of cutter form (part of cutter forming the cutting edge of the drill, see illustration),
A = distance from side of cutter to point where radii meet (see illustration).

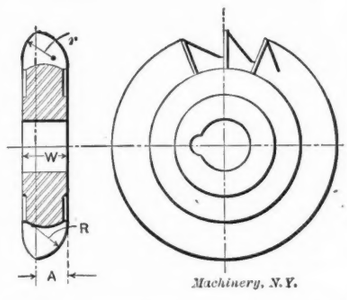
Drill fluting cutters are usually made with eccentric relief, but they also may be provided with ordinary milling cutter teeth, as shown in the accompanying illustration, in which case they must be ground by the aid of standard forms in special fixtures of the type described in the October, 1908, issue of MACHINERY.

The circular arcs drawn with radii R and r should each be tangent to their respective sides of the cutter itself. At the point where they meet, the sharp edge which would result from having the two arcs intersect is slightly rounded off. The radius for this rounded portion is of no particular importance, its object being merely to remove the sharp corner which would otherwise result. When a cutter of this type is used for fluting drills, the curve formed by radius R cuts that part of the groove which represents the cutting edge, while that part of the curve formed by radius r cuts that part of the groove which forms the heel or the back of the drill spiral.

Dimensions are given for the form of grooving cutters for drills from the smallest drill gage size up to 3 inches diameter. It is evident that it is not necessary to have an especially formed fluting cutter for all the sizes specified in the table. As a rule the same cutter can be used for a group of drills, these groups including several sizes below and above the diameter for which the form is specifically calculated. In the case of the "number sizes" of drills, the dimensions of the cutter specified for No. 64, for example, are intended for sizes Nos. 61 to 64, inclusive; those for No. 36, for sizes Nos. 33 to 36, etc.

The table also gives dimensions for the thickness of the web, and the width of the land of twist drills. When speaking of the width of the land, that part immediately behind the cutting edge on the cylindrical portion which is left the full diameter—that is, not relieved—is meant. While the table does not give all the fractional sizes to which twist drills are commonly made, the dimensions for the sizes not given may be easily interpolated.

TABLE OF DRILL GROOVING CUTTERS, THICKNESS OF WEB AND WIDTH OF LAND (PORTION NOT RELIEVED) OF TWIST DRILLS



Diam. of Drill (Drill Gage No.)	W	r	R	A	Thickness of Web of Drill	Width of Land
80	0.013	0.008	0.011	0.007	0.003	No
76	0.018	0.011	0.014	0.010	0.004	clear-
72	0.022	0.015	0.017	0.012	0.005	ance
68	0.027	0.017	0.021	0.015	0.006	0.010
64	0.030	0.019	0.025	0.018	0.007	0.015
60	0.033	0.022	0.028	0.020	0.008	0.015
56	0.043	0.027	0.035	0.025	0.009	0.015
52	0.055	0.035	0.046	0.032	0.010	0.015
48	0.064	0.041	0.053	0.037	0.012	0.020
44	0.073	0.047	0.061	0.042	0.014	0.020
40	0.081	0.052	0.068	0.047	0.016	0.020
36	0.088	0.055	0.073	0.051	0.017	0.025
32	0.101	0.065	0.085	0.059	0.019	0.025
28	0.116	0.075	0.097	0.068	0.021	0.025
24	0.124	0.081	0.104	0.073	0.023	0.030
20	0.133	0.087	0.112	0.079	0.025	0.030
16	0.143	0.094	0.119	0.085	0.027	0.030
12	0.152	0.100	0.128	0.090	0.029	0.030
8	0.160	0.105	0.135	0.096	0.031	0.035
4	0.173	0.114	0.146	0.103	0.033	0.035

Diam. of Drill, Inches	W	r	R	A	Thickness of Web of Drill	Width of Land
15/16	0.750	0.492	0.632	0.445	0.122	0.090
1	0.800	0.525	0.675	0.475	0.128	0.090
1 1/16	0.850	0.558	0.717	0.504	0.134	0.095
1 1/8	0.900	0.591	0.759	0.534	0.140	0.095
1 3/16	0.950	0.623	0.801	0.564	0.146	0.100
1 1/4	1.000	0.656	0.844	0.594	0.152	0.100
1 5/16	1.050	0.689	0.886	0.623	0.158	0.105
1 3/8	1.100	0.722	0.928	0.653	0.164	0.105
1 7/16	1.150	0.754	0.970	0.683	0.170	0.110
1 1/2	1.200	0.788	1.012	0.713	0.176	0.110
1 9/16	1.250	0.820	1.054	0.742	0.182	0.115
1 5/8	1.300	0.853	1.097	0.772	0.188	0.115
1 11/16	1.350	0.886	1.139	0.801	0.194	0.120
1 3/4	1.400	0.919	1.181	0.831	0.200	0.120
1 13/16	1.450	0.951	1.223	0.861	0.206	0.125
1 7/8	1.500	0.984	1.265	0.891	0.212	0.125
1 15/16	1.550	1.017	1.307	0.920	0.218	0.125
2	1.600	1.050	1.350	0.950	0.224	0.130
2 1/16	1.700	1.115	1.434	1.009	0.236	0.130
2 1/8	1.800	1.181	1.518	1.069	0.244	0.135
2 3/16	1.900	1.247	1.603	1.128	0.252	0.135
2 1/4	2.000	1.313	1.687	1.187	0.260	0.140
2 5/16	2.100	1.378	1.772	1.247	0.268	0.145
2 3/8	2.200	1.444	1.856	1.306	0.276	0.150
2 7/16	2.300	1.509	1.940	1.365	0.284	0.155
3	2.400	1.575	2.025	1.425	0.292	0.160

* * *

Thomas P. Brooke of Chicago, has developed a twin revolving cylinder gasoline engine for automobiles and airships in which the gyroscopic action of the engine is dangerous. The principle of the Brooke engine—named the "Non-gyro" motor—that eliminates gyroscopic action is simply the use of two flywheels, or their equivalent, revolving in opposite directions. The helical or corkscrew action of a skidding automobile that overturns when rounding a curve at high speed is largely influenced by the gyroscopic action of the flywheel. If another flywheel of the same weight were running close to it in a parallel plane and at the same speed in the opposite direction, the gyroscopic action would be practically neutralized. Two sets of cylinders in the Brooke engine revolve around the same axis but oppositely. It is claimed that the fatal aeroplane accidents following a glide or dip were due to the twisting of the machine because of the gyroscopic force of the propeller and engine.

"INS AND OUTS OF GEAR HOBBING"—THE FELLOWS CUTTER

By RALPH E. FLANDERS*

This reply to Mr. Lees' letter in the April number of MACHINERY naturally divides itself into two parts. To begin with, the writer will answer in the first person the criticism of his original article in the January number of MACHINERY. The second part of the reply will explain (on behalf of the Fellows Gear Shaper Co., with which the writer is connected) the alarming puzzle propounded by Mr. Lees in relation to the circular pitch of ground-down cutters when used in gear shapers. It should be noted, in passing, that this second question is entirely foreign to the original subject of discussion.

Reply to Criticism of Original Article

I find myself in agreement with Mr. Lees in the main, particularly as to the cause of flats on generated gears. He evidently understands the nature of these flats, which is not the case with some of the other bright men who have written on the subject lately. As he realizes, any flats large enough to be troublesome are not due to theoretical causes, but to practical defects in the generating. If he will but add two more causes to his list—imperfect generating action due to torsional deflection and back-lash in the drive, and inaccuracies due to wear of index-wheels rotated at high speed and pressure—we will be in full agreement.

As to the centering of the hob tooth, we both agree that the distortion of the ordinary hob, as a result of hardening, is so great that it would be hard to find any slight improvement that might be produced by shifting the tooth toward or away from the center line. That conclusion is not disputed by my experiments.

Mr. Lees' scheme of having a straight flute at an angle is interesting. This is theoretically about as good as the helical flute, if allowance is made for its peculiar shape in grinding the teeth and in the form of the relief. Without definite information as to the design and making of the hob, it would not be safe for me to offer criticisms.

Circular Pitch of Gear Shaper Cutters

The other question, relating to the gear shaper cutter, involves an understanding of the nature of the relief of the cutter; and this is a subject, as every student of gearing knows, on which the Fellows Gear Shaper Co. has talked, written and explained continuously for the last dozen years. Will the editor permit valuable space to be taken up by another discussion of so threadbare a subject? Inasmuch as there appears to remain at least one mechanic who has not gotten to the bottom of this elementary matter, and inasmuch as we propose to discuss it in a new and simpler way, it may be that the editor will indulge us while we go over the subject once more. Here is the "direct answer" to the question asked: The sharpening of the gear shaper cutter certainly does reduce its diameter, but the reduction of the circular pitch which thus results does not reduce to the slightest degree the circular pitch of the work, nor does it change the acting tooth surfaces in any way.

To understand this, let us first study Figs. 1, 2 and 3. Here we have the same 10-pitch cutter *C*, which has 30 teeth, generating 30 teeth in each of the three blanks *N*, *L* and *S*. Blank *N* is of the normal size for a standard gear of 30 teeth. Blank *L* is larger than standard, being right for 31 teeth. Blank *S* is smaller than standard, being right for 29 teeth. Gear *N* and cutter *C* both being normal and of the same number of teeth, have of course the same outline on the acting surfaces, the only difference being that the point of the cutter tooth is extended beyond that of the gear so as to cut out the clearance at the bottom of the tooth space.

Gears *L* and *S* were generated by cutter *C*, so it must be that they would mesh with cutter *C*, considering the latter as a gear; and since cutter *C* has exactly the same outline as gear *N*, it is evident that *L* and *S* will both mesh properly with *N*, as shown in Figs. 4 and 5. Furthermore, they will mesh with any standard 10-pitch gear of the same system as that to which *N* belongs. They are both shown meshing with a standard 76-tooth 10-pitch gear in Fig. 6.

Suppose that in Fig. 4, *L*, instead of being an enlarged gear, is an enlarged cutter of the same outline. Since *L* as a gear meshes properly with a normal gear, it is evident that as a cutter it will properly generate a normal gear. In the same way, the abnormally small gear *S* of Fig. 5 could be replaced by a cutter of decreased diameter and of the same outline, and this cutter would generate a normal gear properly. In short, since abnormally large and small gears run correctly with normal gears, the corresponding enlarged or decreased cutters will generate normal gears correctly. This holds good whether a 30-tooth or a 76-tooth gear is being generated, or a gear of any number of teeth from 12 up. So much for the matter of generating the same true involute with cutters of enlarged, normal or decreased diameter.

Now we are ready for this troublesome question of decreased circular pitch. It is a well-known elementary characteristic of the involute gear that the actual or working pitch diameter is a flexible dimension, not a fixed one. This is due to the fact that involute gears run correctly at varying center distances. In Fig. 7, for instance, the nominal pitch line (located 0.100 inch from the tops of the teeth in all these 10-pitch gears) is shown by dotted lines. The actual or working pitch circles are in different positions, as shown by the full lines. Since here we have a small gear running with a normal gear, the center distance is less than normal, and so the two pitch circles (which must touch each other and be equal to each other in diameter, since each gear has the same number of teeth) are smaller than standard. The actual pitch line thus falls outside the nominal pitch line on the small, and inside the nominal pitch line on the normal gear. In Fig. 8, where the center distance is increased by running a large gear with the normal gear, the conditions are reversed.

The student must get a firm grasp on this fact that the pitch diameter of the involute gear is a flexible dimension. This condition applies to the involute form of tooth alone, and not to the cycloidal or to any other system. As a further illustration, see Fig. 9, where the normal gear *N* of Fig. 8 is shown running with another normal gear N_1 of identical dimensions. The same gear *N* which is here running on standard pitch line No. 1, used pitch line No. 2 in Fig. 7. In both Figs. 7 and 9 the action is theoretically as well as practically accurate.

It is this shift in the actual or working pitch line which enables a cutter of decreased diameter to cut a normal gear of standard circular pitch. In Fig. 7, for instance, suppose that *S*, instead of being a small gear, is a cutter reduced by grinding. As measured on the nominal or dotted pitch line, it has a smaller circular pitch than standard, but it is not rolling on that nominal pitch line at all. It is rolling with the mating gear on the actual pitch line, shown by the full line. On this actual pitch line, the cutter, of course, transfers the exact thickness of its tooth to the width of the tooth space *at that point*. At the nominal or standard pitch diameter of the gear, however, shown by the dotted lines, the cutter tooth rocks somewhat as it goes in to and out of action, thus cutting a tooth space wider than itself—just wide enough, in fact, to give the standard width of space at the pitch line for the standard circular pitch. By reversing this train of reasoning, it can be shown that an enlarged cutter having the outline of gear *L* in Fig. 8 will also cut a tooth space of normal thickness at the standard pitch diameter in the standard gear.

Thus we see that we can cut gears of standard dimensions with a cutter so made that it will have the dimensions of gear *L* when new and of gear *S* when ground down, as illustrated in Figs. 1 to 8. Gears *S* and *L*, however, show extreme variations in diameter and circular pitch, the case being exaggerated to show the principle. The real difference in the diameter of the cutter is scarcely one-eighth of that here illustrated, but the principle remains the same. All that has been

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said relating to gears *S* and *L* applies to the cutter as well. Fig. 10 shows a new and Fig. 11 a ground-down 10-pitch cutter. The general resemblance of the change of shape to that of gears *L* and *S* can be traced. For instance (as is shown more plainly in the edge view, Fig. 12) as the diameter decreases, the width of the top of the tooth increases slightly. This agrees with the tooth point of gear *S*, which is slightly thicker than that of gear *L*.

How shall we make a cutter so that it will resemble gear *L* when new and gear *S* when ground down? To answer this,

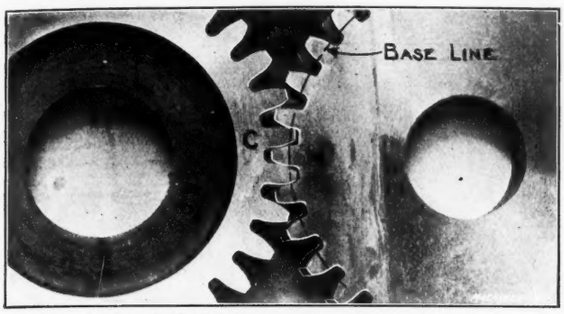


Fig. 1. A 30-tooth 10-pitch Cutter of Normal Diameter generating a Normal 30-tooth Gear

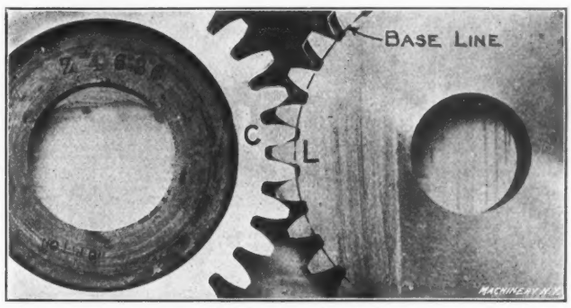


Fig. 2. Normal 10-pitch Cutter generating Thirty Teeth in a Blank of Proper Size for Thirty-one Teeth

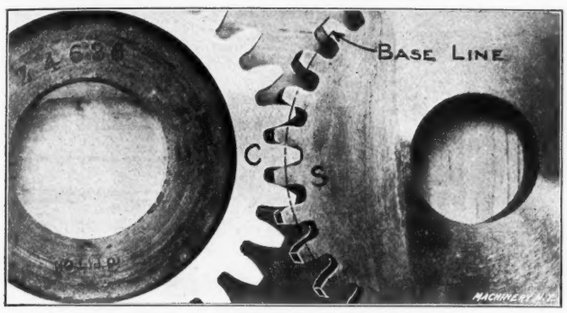


Fig. 3. Normal 10-pitch Cutter generating Thirty Teeth in a Blank of Proper Size for Twenty-nine Teeth

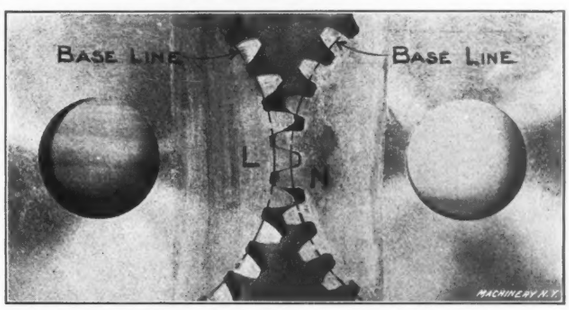


Fig. 4. The Large Gear Fig. 2 and the Normal Gear of Fig. 1 in Accurate Theoretical Mesh with each other

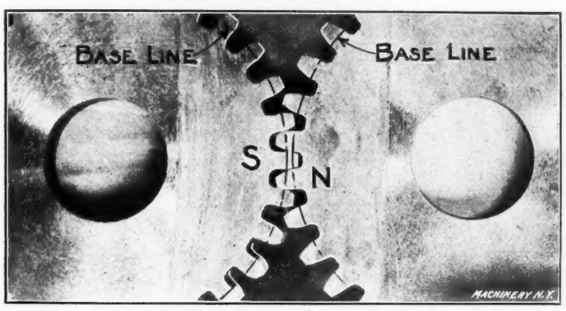


Fig. 5. The Small Gear of Fig. 3 and the Normal Gear of Fig. 1 in Accurate Theoretical Mesh with each other

Fig. 6. The Small Gear of Fig. 3 and the Large Gear of Fig. 2 in Accurate Theoretical Mesh with a 76-tooth Gear

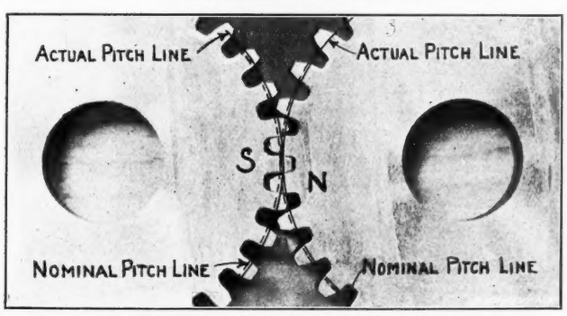


Fig. 7. The Small Gear and the Normal Gear in Mesh, showing the Difference between the Actual and the Nominal Pitch Lines

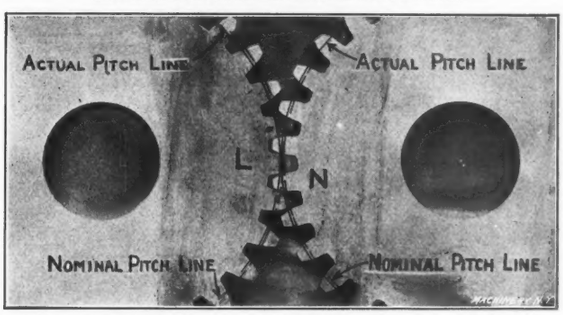


Fig. 8. The Large Gear and the Normal Gear in Mesh, showing the Difference between the Actual and Nominal Pitch Lines

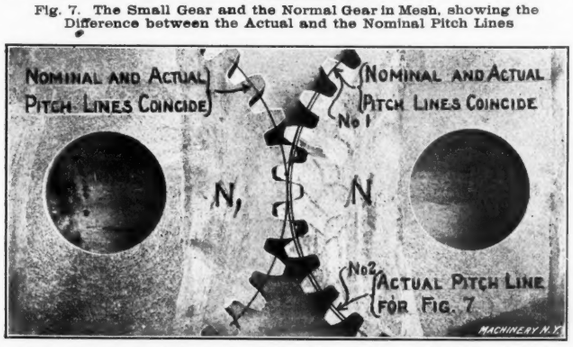


Fig. 9. The Normal Gear of Fig. 7 in Mesh with another Normal Gear, showing the Change in Pitch Line from Fig. 7

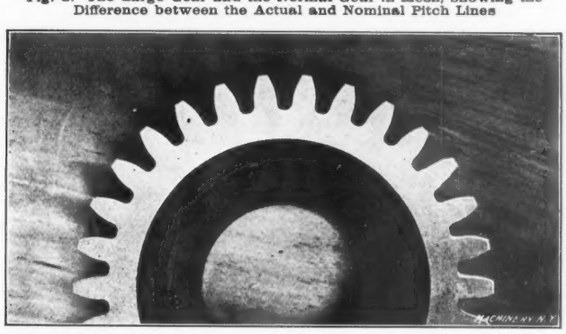


Fig. 10. A New Cutter having an Outline corresponding to the Normal Gear of Fig. 1, or even slightly enlarged, like the Gear in Fig. 2

we must first examine the nature of the tooth curves in *L* and in *S*. The three gears *L*, *N* and *S* are shown superimposed in Fig. 13, with one edge of a tooth of each matched up. Ocular evidence is thus given of the fact that the same involute is used for the teeth of all three gears, *i. e.*, the involute acting surface of each tooth of the three gears *L*, *N* and *S* is developed from the same diameter of base circle. The same identical curve is carried to successively larger diameters on the three gears. (The reader understands, of course, that the points of the teeth will show correction, as with all 14½-degree gears.)

To make a cutter, therefore, whose top, central and lower

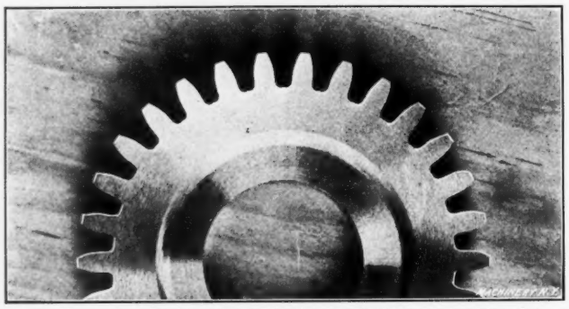


Fig. 11. A Ground-down Cutter having an Outline approaching the Abnormally Small Gear of Fig. 3

sections shall conform to the outlines of *L*, *N* and *S*, we have only to make its teeth all the way from front to back on the same involute curve, generated from the same base circle, but thinner at the back than at the front, in just the same proportion that the tooth of *S* is thinner than the tooth of *L*. The method of grinding this involute shape was described in our advertisement in MACHINERY in January, 1911, page 48, to which reference should be made. We will here simply call attention to the fact that the setting of the spindle of the

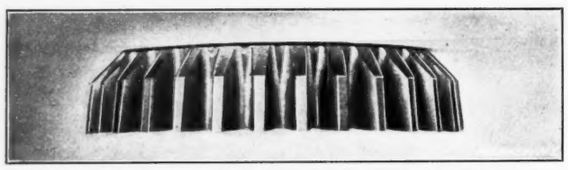


Fig. 12. Edge View of a Cutter, showing the Widening of the Tooth Point as the Diameter decreases

emery wheel to the "clearance" angle thins the tooth of the gear at the back by the required amount, but it does not change the shape of the involute, which is generated from the same base circle throughout the whole length of the tooth.

There is another important practical consideration which should be mentioned in connection with Fig. 6. An abnormally small gear or an abnormally large gear generated on the gear shaper will run correctly with standard gears or with each other. This is exceedingly important, as it makes it

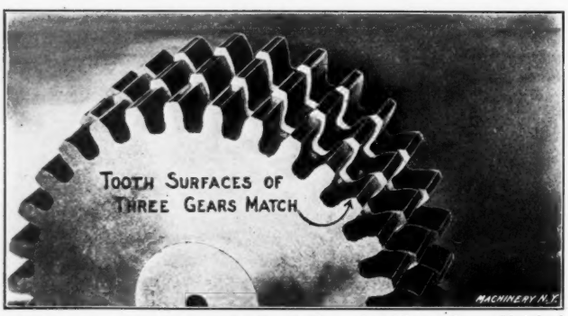


Fig. 13. Tooth Surfaces of the Small, Normal and Large Gears Matched, to show that they are all made from the same Involute

possible to cut theoretically correct running gears for center distances somewhat greater than normal or somewhat less than normal. It also permits cutting gears deeper than standard so as to have a certain amount of back-lash and still have them run correctly. Where considerable back-lash is desired, a ground-down cutter has to be set a few thousandths deeper than a new one, but there is absolutely no change in the acting outline of the tooth, and no change in the tooth action. None of these things can be done with the standard formed and relieved cutter, which must be set at exactly the right pitch diameter to get correctly running gears; there is no flexibility possible. Flexibility of this kind is confined to generated gears only.

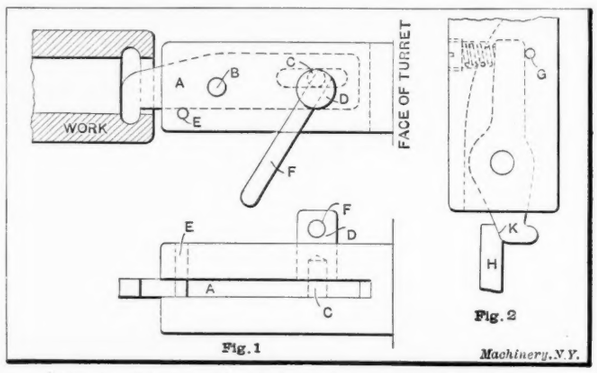
We have chosen to illustrate these elementary principles by simple elementary experiments rather than diagrams, because we wish to make the matter as clear as possible. Anyone with a gear shaper at his disposal can repeat these experiments. Anyone who does this will learn more about the relief of the gear shaper cutter, and about the action of involute gearing in general, than he could learn from whole volumes of reading matter and whole acres of diagrams.

* * *

RECESSING TOOL

On a recent visit to the Robbins & Myers Co., of Springfield, Ohio, manufacturers of electric fans, the writer saw a simple and quickly-operated recessing tool, the principle of which is indicated in the accompanying illustration Fig. 1. The recessing tool *A* is pivoted at *B* and actuated by a pin *C* fitting an oblong slot in the tool. The pin *C* is inserted eccentrically in stud *D*, which is provided, at its outer end, with a handle. It is evident that when the handle is turned it will move the cutting point of the tool out or in, as the case may be. The tool is used in a turret lathe, and the operator, after having finished the other operations necessary, and having brought the turret into position for the recessing operation, simply turns the handle *F* until it assumes the position shown in the engraving. A stop may be provided at *E*, as shown, if the depth of the recess is of importance.

A similar device for recessing in the drill press, the recessing tool being automatically fed into the work, was also seen at the works of the company mentioned. The tool-holder in this case, of course, is held in the drill spindle in a vertical position. The construction of the tool is identical with the



Figs. 1 and 2. Recessing Tools for Turret Lathe and Drill Press

one shown, except that the eccentric pin *C*, stud *D* and handle *F* are not used. Instead a spring holds the tool, when not in action, against a positive stop *G*, as shown in Fig. 2, and a pin *H* inserted in the drill jig operates against the back of the tool at *K*, thus feeding it automatically into the work. As the tool is sketched from memory, the actual construction may have been slightly different, but the principle involved is clearly indicated. E. O.

* * *

An interesting device for pulling shaper rams when scraping is used in the Walcott & Wood Machine Tool Co.'s shops at Jackson, Mich. When scraping in a shaper ram, the machine to be scraped is placed in front of another shaper, and the ram of the shaper to be scraped in is attached by a link to the ram of the other shaper, and is pulled to and fro by the motion of this shaper. This is a simple and convenient arrangement and has proved very satisfactory.

* * *

A writer on machine photography states that the "pose" of machinery is a matter of much importance if the best effect is desired. "Reciprocating parts should not be shown at the end of their travel; their functions and form are much easier seen, as a rule, if they are at some intermediate, but not exactly mid-position."

DEVELOPMENT IN LODGE & SHIPLEY LATHE PRACTICE

In the June, 1909, number of MACHINERY, in the department of New Machinery and Tools, a crankshaft lathe built by the Lodge & Shipley Machine Tool Co., Cincinnati, Ohio, was illustrated and described. One of the novel features of this machine was the provision made for positive stops for both longitudinal and cross movements. These stop arrangements

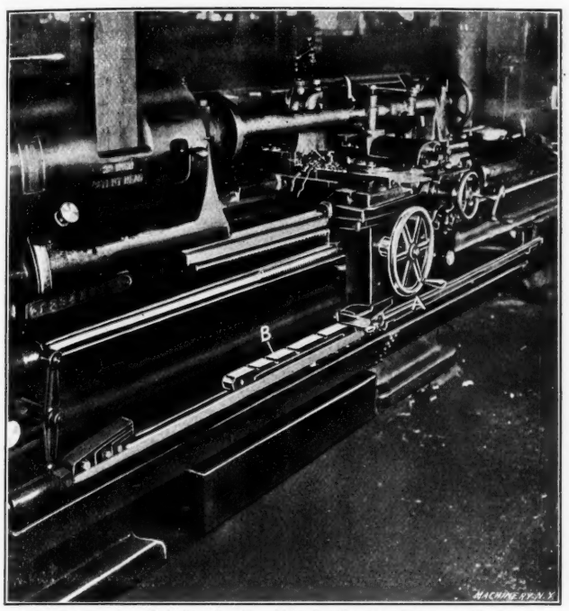


Fig. 1. Turning Spindles by the Aid of a Spacing Bar on a Lodge & Shipley 22-inch Lathe

are now provided on other types of Lodge & Shipley lathes as well, and the application of the longitudinal stops to manufacturing work is of especial interest.

The essential features of the longitudinal stops are, briefly, as follows: A rectangular bar *A*, Fig. 1, is placed in the front of the bed, just below the apron. This bar slides in brackets bolted to the bed. To this bar are clamped stops adjustable the entire length of the bar. At the bottom of the apron is bolted a bracket with a pivoted arm which engages with the stops on the sliding bar. When engagement takes place, the bar slides with the carriage, and by means of the mechanism at the headstock end, a clutch on the lead-screw is drawn out of mesh and the feed stopped.

It is evident that while the stops can be set to take care of any manufacturing work, insuring that all the parts are turned alike, it is necessary to set them for each lot, if the machine has been used, in the meantime, for other work. This setting, of course, requires time, and unless carefully done, slight inaccuracies may creep in, making the work not strictly interchangeable. For this reason the Lodge & Shipley Machine Tool Co. has adopted a system of standard spacing bars for work that is put through the shop in lots from time to time. A collection of these spacing bars is shown in Fig. 2, which illustration also indicates the method by which they are kept when not in use on the lathe. These spacing bars, when used, are placed on the sliding bar previously referred to, and act as a substitute for the adjustable stops. In these bars each notch acts as a stop for a shoulder on the work turned, and as in this case one bar is used for each piece of work, there is no need of setting the adjustable stops for standard work. All that is required, after a spacing bar has once been provided, is to place it in position on the sliding bar, and the workman can proceed with his work. The spacing bar acts as a jig, insuring that every time the same bar is used, interchangeable work will be produced. It will be understood that the pivoted arm on the apron bracket drops into each of the slots in the spacing bar successively, instead of engaging the individual adjustable stops, and that thus a permanent relation is established as regards the distance between the shoulders on the work.

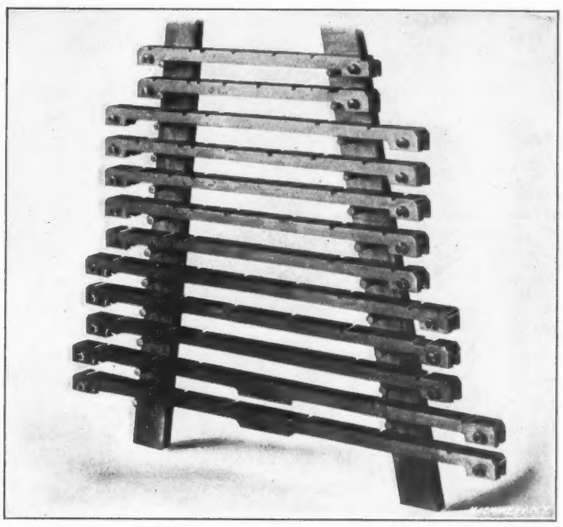


Fig. 2. Rack for Spacing Bars used on a 22-inch Lodge & Shipley Lathe for Spindle Turning

An important feature is that these spacing bars can be kept in the tool-room, and that the workman calls only for the one required for the work in hand. The bars are all stamped for ready identification, and mistakes are thus guarded against.

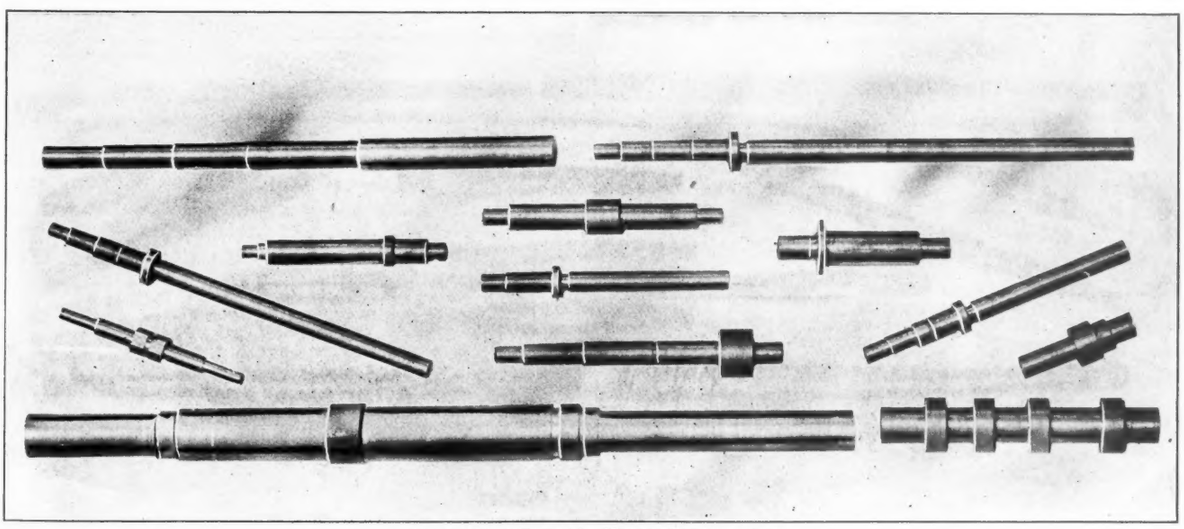


Fig. 3. Work Turned by Means of Spacing Bars

In the accompanying illustrations, Fig. 1 shows the finish turning of spindles by the aid of a spacing bar *B*. Fig. 2, as mentioned, shows the spacing bars, while Fig. 3 shows shafts and spindles turned by the aid of spacing bars.

COMMUTATOR MAKING

By ALTER EGO

As electrically-driven machinery becomes more generally used, many shops will have more or less to do with the making and repairing of generators and motors, and so for that reason, an article dealing with the manufacture, should prove acceptable. The writer, after going through the many stages of experimental construction and having to devise ways and means for the practical production of several sizes of small motor commutators has worked out a system of tools and operations that has proved very satisfactory. In a general way, what is true in the making of one commutator is also true in the making of a greater number; this has been borne in mind throughout.

In an electrical sense at least, the word "armature" implies commutation, and commutation means a change in current direction, which change is brought about through the medium of a very pretty mechanical contrivance technically

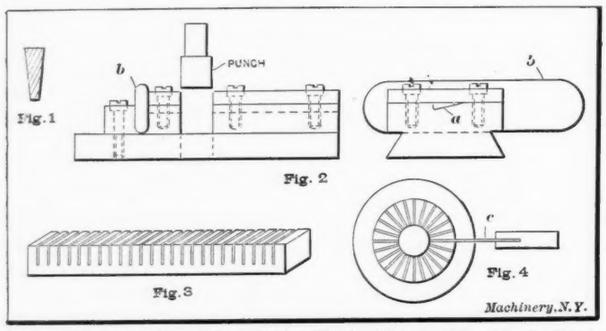


Fig. 1. Section of Copper Rod Stock. Fig. 2. Shearing Die. Fig. 3. Stock Rack for Copper and Mica Pieces. Fig. 4. Assembling Ring

called a "commutator." Briefly stated, a commutator is made up of a number of wedge-shaped copper segments separated or insulated one from another by carefully measured and selected pieces of sheet mica. The copper is first accurately rolled into rods of any convenient length, these rods having a cross-section more or less wedge-shaped—more accurately sectors of a circle—the angle changing as the number of sections in the commutator increases or decreases. Such a section is shown in Fig. 1.

The first machine operation after rolling the stock is that of cutting the segments to length. Sawing off was tried and found too slow and wasteful of stock, so shearing-off has been tried and proved successful. The die used, shown in Fig. 2, is a very simple one and, being made in sections, can be repaired at little expense. In operation, the stock is introduced into an opening in the end of the die, this opening being slightly larger than the stock, and so constructed that the upper side is in a flat or horizontal position as at *a*,

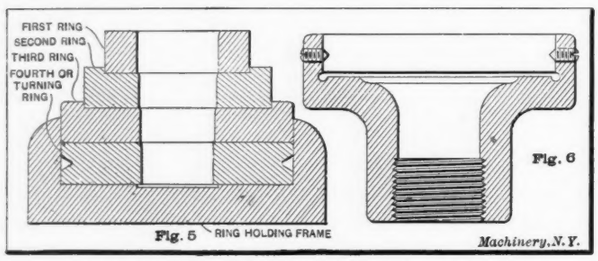


Fig. 5. Compression Rings and Holder. Fig. 6. Chuck for Holding Rings in Turret

Fig. 2; the stock is pushed ahead until it comes against the stop *b*. With the descent of the punch, two pieces are cut off, one dropping through an opening in the die and the other remaining until the stop *b* is withdrawn, the stock on being forced ahead knocking this piece out. The stop is then replaced and the operation repeated. The die is made in three sections, namely, the left, center, and right. The left and center sections are of the same width and determine the length of segment; the sections left and right are covered, the purpose being to support the stock on all sides, by which means the copper segments are delivered from the dies with practically no rounding off or breaking down of the edges.

Consider an order for a lot of commutators of, say, 24 sections each. The copper segments and mica insulations, having been inspected, are placed in racks such as shown in Fig. 3, each holding just 24 pieces; without these racks trouble might be experienced from introducing one too many or too few pieces into the commutator which might not be discovered until too late to be corrected. The counting of these pieces after they are assembled would be rather a tedious and difficult job. In assembling, use is made of a ring having a

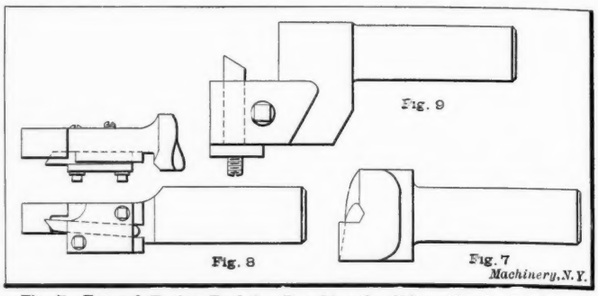


Fig. 7. Formed Facing Tool for Roughing the Sides. Fig. 8. Single-point Tool for Angular Recesses. Fig. 9. Outside Roughing Tool using Cutters Interchangeable with those in Fig. 8

hole large enough to easily take in all these pieces; such a ring is shown in Fig. 4. This ring has a slot cut in it to receive a removable blade *c*. Around the inside of the ring and resting against the blade are placed on end pieces of copper and mica alternately, until 24 pieces of each have been assembled; when the ring is filled, the blade is pulled out and the pieces are bound together with a wire to form a blank.

The next operation is that of compressing the blanks, and consists of forcing them through a number of cast-iron rings, which have slightly tapered holes, a set of which is shown in Fig. 5. The first ring is of such a size that it permits of the blank being pressed in by hand, this operation straightening up the copper and mica if at all twisted. The second ring is made somewhat smaller, and a pressure of about two tons is used to force the blank in. A third ring is still smaller and a pressure of about five tons is used this time,

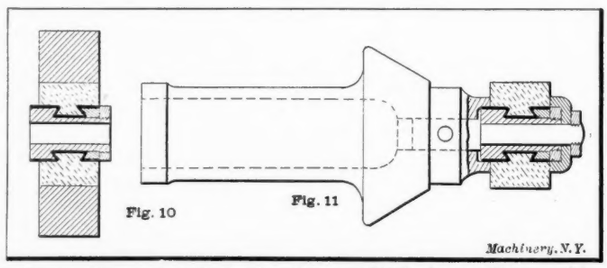


Fig. 10. Section through Turning Ring and Blank showing Sleeve and Insulations assembled ready to be faced from Ring. Fig. 11. Turret Lathe Arbor indicating method of Clamping the Copper by the Sides

while the fourth ring, which will be called the "turning" ring, because the turning is done in it, is so constructed that a final pressure of about seven tons gives all the needed compression. It is obviously impractical to have only one ring in which to turn the blanks, and it would be equally impractical to have one for each commutator when making them in large lots. However, as these rings may be made at small cost, a stock of from five to ten per cent of the number of commutators to be made, will be sufficient. The large side of the hole in the turning rings is well rounded to allow the blanks to enter without shaving the sides, hydraulic presses being used for this purpose. The slow, steady action of these presses is very desirable, giving ample time for the parts to adjust themselves.

The rings are now put into a special turret lathe chuck, Fig. 6, and finished completely inside and roughed on the outside faces, allowance being made for final finishing; Figs. 7, 8, and 9 show the tools employed for the purpose. Copper is not a good material to work in a screw machine, and when there is an additional five to ten per cent of mica, trouble

arises that calls for much care and patience on the part of the operator. The use of oil, soapy water or kerosene emulsions in the machining of commutators, is for chemical and electrical reasons, prohibited. Good turpentine is perhaps the best tool lubricant that may be used, for in drying out it leaves a thin coating of resin that in itself is a good insulator and is not likely in its chemical change to attack the copper, setting up an electrolytic action which may eventually cause a breakdown of insulation. All tools other than the drill and reamer for the sleeve hole are of the single cutting point style and so made that they may be ground without changing their shape. All are made from some of the various high-speed steels and are left as hard as they can be used; and yet they require constant attention to keep them in such a condition that they will not drag the copper across the mica insulations.

In view of the difficulties encountered in machining, controlling sizes, etc., and the non-essential features involved in this piece, very liberal limits are allowed up to the point of assembling the sleeve and insulation. Limits of from 0.001 to 0.003 inch for all inside diameters and 0.002 to 0.005 inch for thickness are not excessive and may be maintained without much trouble to the operator.

Small commutators such as those under consideration, are seldom repaired; by this is meant that they are not taken apart in order to replace pieces. The smallness of the parts, trouble of refitting insulation, and the general design, make this impractical; therefore absolute interchangeability of parts is in no way essential to the making of good commutators. After the first side of the blank has been machined, the ring is reversed in the chuck and the other side machined. When taken from the chuck, the piece looks bright and clean, but upon examination under a glass, little chips and threads of copper crossing over the mica from section to section may be found; these must all be very carefully removed or trouble is sure to follow. Time spent on this operation will more than pay for itself later on. After cutting and scraping away these small short-circuits, the sleeve, clamp-nuts and the various insulations are ready for assembling to the copper blank. Assuming that the insulations have been made up ready for use, the amount of trouble likely to be experienced in this operation depends largely on the nature of the material from which these insulations have been made. Consider briefly the three kinds of material most generally used for this class of work:

Mica—a mineral—owing to its peculiar structure, does not lend itself readily to any sort of shaping; therefore, for use it must be cut as nearly as possible to the form needed, building up thin pieces until the form and thickness have been made, binding the whole together with thin shellac, and finally putting it into place while wet.

Micanite—a commercial article—is made up of thin sheets of mica pasted together with shellac, copal, sandarac or other heavy gum varnishes; it is then placed between hot plates, the excess of binder squeezed out, and after cooling, it is ground to the desired thickness. From these sheets many forms may be cut and molded by heating in suitable forms, thus making less work in assembling.

Vulcanized fiber—a vegetable fiber chemically treated—may be purchased commercially in many sizes, in the form of sheets, rods, tubes and special forms, and with little machining makes a most desirable insulation, its one drawback being its liability to swell and shrink under varying atmospheric conditions. Experience has shown that if this material be well dried before machining and afterward coated with some good moisture-resisting varnish and then well baked, it will be found to have lost its hygroscopic properties to a marked degree.

Much has been done to prove the values of different kinds of insulating materials, and from these records it has been found that the values of the insulations are rated in the following order: Mica, micanite, and fiber. The fact that it is third in the scale, does not condemn the fiber, as these scales of values have been calculated for cases involving great power and high voltages, and in no way apply to small motors that seldom operate on more than a 220-volt circuit. This fiber insulation, 0.032 to 0.062 inch thick, will safely stand five to six times this voltage without breakdown or other signs of distress.

Having assembled the parts and tightened up the nut as much as possible, as in Fig. 10, the copper blanks are forced from the turning ring. These rings may now be re-filled and the foregoing operations repeated.

The outside turning is now in order and is to be done in the turret lathe, the commutator being held by a clamp arbor, Fig. 11, so made that the piece is clamped on the copper sides; if held in any other way, there is danger of the sections turning and pulling out of the sleeve, completely destroying the commutator. In the machining, front and back roughing tools are used for the flange diameter, and first and second roughing box-tools for the body diameter; these with the necessary gages complete the outfit for this operation, 0.008 to 0.010 inch being allowed for a finish turning. After the roughing operation is completed, the sides, flange and body of the commutators are skimmed or finish turned with a fine-pointed tool in a bench lathe. If provision is made to face the copper, working from the sleeve ends, it is possible with very little care to get these pieces into an interchangeable condition as regards outside dimensions.

After skimming, the slots for the armature wires are milled, one for each section in the commutator; two cutters may be used to good advantage in this operation. The milling of the wire slots marks the ending of the machine operations on these commutators and they are ready for a very careful inspection with an ohmmeter, galvanometer or simple "trouble-finder" that may be attached to any electric-light wire, indicating at once if there is a short circuit or a "bug"—as it is called in shop parlance—in the commutator. This so-called "bug," is usually a small chip—a sort of connecting link—between two or more segments or between any segment and the sleeve; this must be found and removed. Many expedients are resorted to in doing this, and these will suggest themselves to the workman, but the most successful and the cheapest one in the end, when the fault is known to be on the inside, is to throw the commutator away, for by so doing, the company will be saved money and the mechanic a good deal of trouble.

On the other hand, should the inspection show a perfectly insulated commutator, a slow baking for a day or two at a low temperature of, say 120 degrees F. will complete the job. If, now, out of the total number of commutators made, the loss is not greater than five per cent, the workman is to be congratulated.

* * *

In the shops of the Bradford Machine Tool Co., Cincinnati, Ohio, special tools and gages are provided for every operation, and if in the same piece there are, for example, several holes to be reamed, one reamer is provided for each hole even if the holes should be of the same size. Each hole is tried with a standard plug used for that hole exclusively, and when the reamer is found to be under size it is immediately sent to the tool-room for re-adjustment and grinding. Gages are used for setting the taper attachment on the lathes when turning standard tapers. The gages used are not short gages of the regular length that would be required for the standard taper, but are made from three to four times longer than the length of the standard taper shank, so that in setting the taper attachment, greater accuracy is possible on account of the length in which the taper is measured.

* * *

An Irishman recently over from the "ould sod" took a job in a machine shop as a handy man, and, being naturally smart, soon advanced. One day he was set to work on a shaper and everything seemed to be progressing favorably except from Mike's viewpoint, for he called the boss over and remarked: "Oi don't loike the way this machine runs. When she digs in when going ahead and working hard, why doesn't she take her toime when she's coming back?" You see he was comparing a shaper to a wheel-barrow. V. J. M.

THE PROBLEM OF CONE FRICTION CLUTCH DESIGN

By A. C.

The article entitled, "The Problem of Cone Friction Clutch Design," from the pen of Mr. Oskar Kylin, which appeared in the February number of MACHINERY, engineering edition, is a very useful one, and while the writer does not entirely agree with all the conclusions there drawn, he thinks that Mr. Kylin is to be commended for his able treatment of a subject concerning which there is but little reliable information.

The importance of this type of friction clutch as a detail of modern machine construction will probably increase in the future as quick-acting machinery becomes still further developed for (in the opinion of the writer at least) the speed limit for the expanding clutch is now approaching. As an instance of this, there is at the present time a machine being built with a more or less complicated combination of cone friction and positive reversing clutches, the designer claiming that expanding clutches would not be suitable, for the high speed develops a sufficiently great centrifugal force to

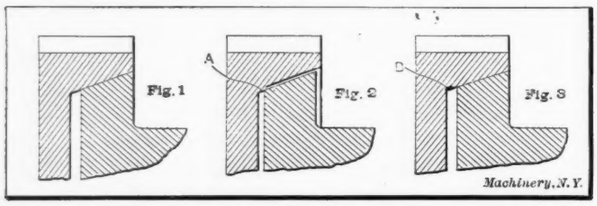


Fig. 1. Clutch as shown by Mr. Kylin's Drawings Fig. 2. Result of Wear on the Clutch shown in Fig. 1. Fig. 3. Clutch designed to compensate for Wear, by removing Triangular Ring B

expand the clutch ring (the idle one), materially affecting the efficiency of the machine. Whether this is actually true or merely a talking point for the combination, the writer does not profess to know, but it would seem reasonable to assume that such a condition is well within the realm of possibility, particularly when it is remembered that centrifugal force increases directly as the square of the velocity. It is evident in this respect that the cone clutch has the advantage, because it is obviously impossible for it to expand, no matter how high the speed may be within practical limits.

Another point wherein the cone clutch is superior, lies in the better distribution of the pressure. The writer has seen several expanding ring clutches in which the wear (and therefore the pressure) was confined to two comparatively small portions of the rings immediately opposite the expanding mechanism. In the case of the cone clutch this would be impossible if ordinary care were taken in the design and construction, for the pressure would be equally distributed over the whole of the friction surfaces, making possible a greater unit pressure.

In addition to the two advantages just named, it is probable that, from the standpoint of simplicity and ease of adjustment, the expanding clutch is outdistanced. This statement is rather general and perhaps should be qualified slightly, for some expanding clutches are quite simple; but speaking generally the cone clutch is much better where simplicity is concerned.

The first and most important item to be considered among the details of design is the unit pressure allowable on the friction surfaces. What is the maximum pressure under varying conditions of speed, different operators, etc., that can be maintained day after day without undue wear? Referring to standard engineering text- and hand-books, it will be found that the majority devote more or less space to the design of ordinary journal and other types of bearings, and it will also be found that the allowable pressure per square inch of projected area varies between remarkably wide limits; thus for slow-moving shafts, a safe limit of 3000 pounds per square inch is given, while for propeller thrust bearings, from 50 to 70 pounds per square inch is about the average—other classes of bearings come somewhere between these two.

It must be remembered, however, that these figures are for bearings in which the rubbing action or operation is constant, and it will be found that for a bearing in which the pressure alternates diametrally from side to side, as, for instance, in a crank-pin a considerably higher unit pressure is allowable. The reason advanced for this is that the bearing, when relieved of pressure on one side, lets oil into that side from external sources, and to some extent from the pressure side as well; also when the pressure does come on the bearing the period during which it acts is so short that the oil cannot be altogether squeezed out.

While in some instances friction clutches are operated quite frequently, there are certainly no cases where the operation is as frequent as the revolutions in the slowest of steam engines, and while in the latter the crank-pin bearing rubs or slips on one side or the other constantly, the bearing surfaces of a friction clutch slip very little. The slip that does occur is confined to a very short period at the moment of engagement, and it is quite probable that slipping has ceased before the oil with which the friction surfaces cannot fail to be covered, has had an opportunity to be squeezed out.

If then, the conditions under which the crank-pin and friction clutch operate are similar, it would appear that Mr. Kylin very clearly underestimates the unit bearing pressure allowable when he advises a pressure of only 60 pounds per square inch for the reversing clutch which he cites. Even on high-speed engines the unit bearing pressure for the crank-pin is as high as 600 pounds per square inch, while at low speeds it may reach as much as 800 pounds per square inch.

As an example of what has been done at higher pressures the writer will mention a clutch which he has designed: Mean diameter, 4¼ inches; width, 1 inch; maximum speed, 600 revolutions per minute; unit working pressure, 260 pounds per square inch; both members of the clutch made of cast iron. In service, the clutch is engaged about 100 times a day, and though rarely engaged or reversed while under load, the fact that there were four shafts and three pairs of

TABLE OF FRICTION CLUTCH DATA

Case	Horsepower Transmitted	Revolutions per Minute	Diameter, Inches	Width, Inches	Surface, Square Inches	Surface Speed, Feet per Min.	Tangential Force or Resistance R	Pressure between Surfaces to produce R $\mu = 0.1$	Unit Pressure, Pounds per Square Inch
								Pounds	
1	4	600	3	1	9.5	430	310	3100	325
2	4	300	5	1	16	390	335	3350	210
3	8	400	6	1¼	24	630	420	4200	180
4	12	400	7	1¼	28	730	540	5400	200
5	4	30	8½	1½	40	67	1970	19700	495
6	4	30	9	1¼	35	71	1860	18600	525
7	8	25	10	1½	47	65	4000	40000	850
8	12	20	12	1½	57	63	6300	63000	1115
9	7½	6	16	1¼	63	25	9900	99000	1570

gears to be accelerated to a speed of 600 revolutions per minute, gives some idea of the work it performed. The bearing surfaces of the clutch were turned out with a fine feed of about 1/60 inch per revolution, but after running about six months, it was found that very close examination was required to discover any wear at all, as the feed marks were but slightly worn; in this case the only oil on the friction surfaces found its way there from the bearings as there were no special facilities for oiling the frictions. Of course, it will be readily understood that all oil working out from the inner end of the gear bearing on the shaft must be drawn onto the friction surfaces, and this applies in a varying degree to friction clutches of all designs.

The accompanying table was published in the *American Machinist* some years ago in an article on the theory and design of friction clutches, and while it has special reference to expanding clutches, it seems a safe premise to use the same figures for cone clutches. The writer of the article mentioned, asserted that some of the clutches tabulated were in actual use, and had given every satisfaction for years. Both parts of these clutches were of cast iron. He also pointed out that the driving power of a friction clutch was

increased about 20 per cent if a number of transverse grooves were cut across the face of the inner clutch. The reason assigned for this was that the oil was thereby allowed to escape more quickly. In the clutch designed by the writer (previously referred to) there were twelve of these grooves equi-distantly spaced around the circumference, cut about 1/16 inch deep with a 12 to 13 tooth, 7 pitch gear cutter.

In conclusion the writer would like to point out another little detail of construction which though insignificant in itself is of sufficient importance in its results to merit consideration. The length of the bearing surfaces should be exactly equal in both parts of the clutch. Fig. 1 shows the condition as existing in Mr. Kylin's drawings; when any wear takes place the clutch will be in the condition as shown exaggerated in Fig. 2, all the pressure being taken by a narrow strip of metal at *A*. If all the metal represented by the triangle *B* in Fig. 3 were removed, no matter how much wear took place there would always be a full bearing between the two parts of the clutch.

* * *

SPLICES FOR ANGLES

I note in the April number of MACHINERY, engineering edition, an article entitled "Splices for Angles," with accompanying Data Sheet Supplement. It is unfortunate that this Data Sheet was not revised by some one familiar with good practice in such details. I call your attention to this because your Data Sheets are often used with the utmost confidence by those who are unable to detect errors for themselves. Many who are not well acquainted with good shop practice are permitted to detail important structural work, and those of us who are in this business know that they often insist on designs being followed that are little short of criminal. The writer has not gone through the details with reference to number of rivets, etc., but would call your attention to the following violations of accepted practice:

The splices detailed may be used for compression, but the spacing of 4 inches is longer than needed in angles with a single line of rivets. The larger sizes of angles could be better spliced by using an inside angle in addition to the outside bars. When the splices are used in tension members, a more serious fault is to be found, because the net section of the angle is unnecessarily reduced by cutting one rivet from each leg at the same point, and by spacing the rivets next to the ends of the splice-bars so close that more than one rivet should be deducted from each leg having two lines of rivets. This also applies to rivets near the center of the splice-bars.

It is possible to detail these splices so that one rivet hole only need be deducted from the entire angle, and a standard splice should be so arranged. It should also be noted that the use of end distances of 1 and 1⅛ inch is bad practice from every point of view. One-inch rivets should seldom, if ever, be used for splicing 8 by 8-inch angles, and certainly not in ¾-inch metal.

Everett, Mass. E. N. PIKE
Chief Engineer New England Structural Co.

Mr. Pike deplores the fact that the Data Sheet "Splices for Angles" was not revised before publication by someone familiar with good practice in structural work. I would say that I am not exactly a novice in such matters; neither, I believe, is the editorial staff of MACHINERY. Now let us analyze the points which Mr. Pike intimates are but little short of criminal. The rivet spacing of 4 inches objected to occurs in the 4- and 3½-inch angle splices, with minimum thickness of metal ⅜ inch, or one-eleventh of the rivet pitch. A standard structural steel specification contains this clause: "The pitch of rivets in the direction of the stress shall not exceed 6 inches or sixteen times the thickness of the thinnest plate connected."

As regards the supplying of an inside angle in addition to the splice-plates shown, a careful scrutiny of these splices will reveal the fact that their lowest tension efficiencies are for the net section of the angles. Any further addition of splice-plates to those detailed will not increase this efficiency; besides the bending efficiencies of the splice-plates shown are in every case more than 100 per cent. Therefore, adding to the splice-plates would appear to be needless and of little value.

These splices are not so much at fault when in tension as Mr. Pike would have us believe. The rivets are staggered in the splices which have a single row of rivets in each leg, while in those splices having two rows of rivets in either or both legs the rivet arrangement is such that the loss from rivet holes is a minimum. It is true that in splices having three or four rows of rivets, the rivets come opposite each other, and this is necessary if a symmetrical design is to be obtained. The carrying out of the suggestion that the rivet spacing should be such that the net section of the angle would be only one rivet hole less than the gross section, would result in much longer splice-plates, and therefore heavier and more costly splices. For example, in the splice for the 4 by 4 by ½-inch angle, the net section of the angle when in tension is $\frac{1}{2}\,(1\frac{7}{8} + 1\frac{7}{8} + \sqrt{[2\,(2\frac{1}{8} - \frac{1}{4})]^2 + 2^2} - 2 \times 13/16)$, or 3.2 square inches. Since the gross area is 3.75 square inches, the area lost is 0.55 square inch or equal to 1 1/3 rivet hole. To reduce this loss to one rivet hole the rivet spacing must be 5⅛ inches. But it has already been objected to that the rivets are as far apart as 4 inches! Placing the rivets in this splice 5⅛ inches apart will not allow the splice-plates to be made much thinner, so their weight will be increased 25 per cent, while the increase in the tension efficiency of the splice is only 3 per cent. The 4-inch spacing was chosen in this case as a compromise between high efficiency and an unwieldy splice.

The spacing of the rivets from the ends of the angles and splice-plates is in no case less than one and one-half times the diameter of the rivets used. This is good practice, and a clause referring to it is found in dozens of first-class specifications for the fabrication of structural steel. If a rivet is placed 1½ diameter from the edge of the plate, the metal in front of the rivet will never shear out. The joint will fail either by shearing off the rivet or crushing the plate at the rivet, due to excessive bearing. I have at hand a set of standard splices used by the Baldwin Locomotive Works in their locomotive boilers. In every case, from a double riveted lap joint to a triple riveted butt joint, the outer rows of rivets are located 1½ rivet diameter from the edges of the plates.

In the general run of structural work, rivets larger than 1 inch are seldom used, except in special cases. A pneumatic riveting hammer cannot successfully drive larger rivets, and therefore field connections are usually made with 1 inch rivets or smaller. Then, to avoid having more than one size of holes the shop rivets are detailed the same size as the field rivets. The American Bridge Co. built in 1908 for the LaSalle Hotel in Chicago a girder truss 74 feet long, 26 feet deep, and weighing 110 tons. The gusset plates are 1 inch thick, while the built-up members are made of plates and angles from ¾ inch to 1 inch thick. All the rivets in this truss with one or two exceptions are ⅞ inch in 15/16 inch holes. No less a structure than the lamented Quebec bridge, which failed in 1907 during erection, was largely built with ⅞ inch and 1 inch rivets.

In conclusion, the writer wishes to state that the major purpose of the article in question was to show how a set of angle splices of high efficiency could be designed, thus giving each one the means of designing them to suit his own standards. However, a careful examination of the designs submitted will prove them to be an excellent compromise of the conditions involved, and safe to use if the efficiencies given are considered when introducing any of these angle splices in a design. A. L. CAMPBELL
Detroit, Mich.

* * *

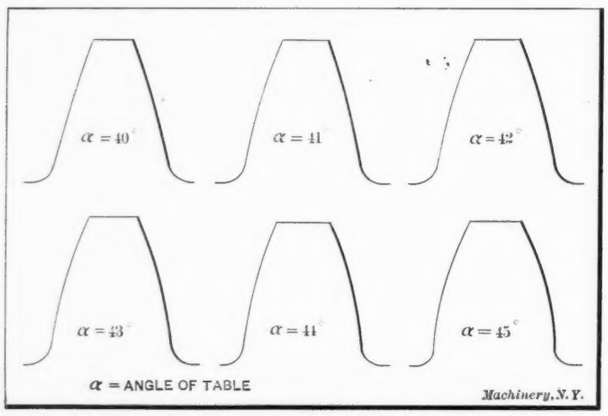
The National Tool Co., Cleveland, Ohio, employs a simple and effective method of marking its milling cutters and other tools manufactured. The name of the company and the size of the tool are engraved with an electric pencil. The apparatus consists merely of a primary battery generating a current of from twelve to fourteen volts and a tool consisting of an insulated pointed copper rod connected by flexible cord to one pole of the battery, the other pole of the battery being connected to a plate on which the cutter to be marked rests. The operator uses the tool the same as an ordinary pencil. The metal of the cutter is fused as the pencil traverses the surface, the lines of the writing showing as shallow grooves in the face of the hardened metal.

THE SETTING OF THE TABLE WHEN MILLING SPIRAL GEARS*

By GEORGE W. BURLEY†

It has been recently and severally stated that the most suitable angle (and the one most likely to produce the best results) at which to set the table of the milling machine when milling spiral gears, is that corresponding either to the diameter of the gear measured at the bottom of the space, or to the diameter measured at the working depth. The reason invariably adduced for this is that, if the angle chosen is the angle of the spiral measured on the pitch cylinder of the gear, an undue amount of undercutting, and therefore weakening, of the teeth will occur, owing to an excessive amount of interference with the sides of the teeth on the part of the cutter; and that, therefore, a somewhat smaller angle should be selected to reduce these effects.

To determine whether there was, practically, anything in this idea or not, the writer recently made some experiments on a spiral gear, the immediate object of the experiments



Shapes of Teeth obtained by Setting the Table at Different Angles, Cutter and Lead remaining the same

being to find out what the effect of altering the angle of setting of the milling machine table was upon the shape of the tooth cut.

The experiments were made upon a cast-iron gear, with a pitch diameter of 4.242 inches, and designed for 24 teeth, the diametral pitch (corresponding to the normal circular pitch) being 8. The correct cutter to use was determined by the formula $N_e = \frac{N}{\cos^3 \alpha}$, this cutter being No. 3 in each of the cases dealt with. The experiments consisted of cutting six teeth in the gear blank, all being of the same depth, the angle of

TABLE OF OBSERVED TOOTH DIMENSIONS

Angle of Table Setting, Degrees	Width of Tooth at a Depth of Inches						
	0	0.050	0.100	0.125	0.150	0.200	0.250
45	0.104	0.145	0.185	0.200	0.203	0.221	0.239
44	0.102	0.144	0.181	0.195	0.202	0.220	0.238
43	0.099	0.142	0.176	0.188	0.200	0.218	0.236
42	0.094	0.135	0.168	0.180	0.196	0.215	0.234
41	0.087	0.128	0.158	0.171	0.185	0.211	0.232
40	0.078	0.115	0.146	0.158	0.171	0.205	0.230

setting of the table of the milling machine being different in each of the six cases. The spiral angle measured on the pitch cylinder was 45 degrees, the lead of the spiral being 13.32 inches, for which the gears of the spiral dividing-head were arranged. The six spirals chosen were at angles of 45, 44, 43, 42, 41, and 40 degrees, each tooth being formed by two cuts at one angle, the lead of the spiral remaining the same throughout the series of tests. It should be here noted that 43 degrees is the angle which corresponds to the diameter measured at the bottom of the space, and is the one which, in accordance with the reason referred to above, would be recommended as the angle of setting of the table.

The profiles of the teeth taken as sections normal to the spiral on the pitch surface are indicated in the accompanying engravings, these being drawn to scale accurately, the scale adopted being three times full size. The various widths of the teeth at different depths were obtained as accurately as possible by means of a Brown & Sharpe gear-tooth vernier caliper. These widths are given in the accompanying table.

Of course, it will be readily seen that although great care was exercised in securing measurements that would be as accurate as possible, the dimensions given above may be incorrect to the extent of one or two thousandths inch, though not more.

In regard to the shapes of the teeth, it will be noticed that the 40-degree tooth is slightly undercut at the root, while the other teeth do not show any undercutting whatever. The undercutting referred to in the 40-degree tooth, amounts to a reduction in width below the widest part of the tooth of about 0.010 inch.

The deductions drawn from the results of these tests are:

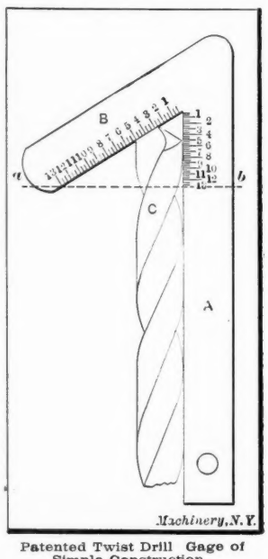
1. That the practice of setting the table at an angle less than the spiral or helix angle measured on the pitch surface is justified; though this angle should not be less than the spiral or helix angle measured at the bottom of the tooth.

2. That a cutter for a larger number of teeth than that given by the formula $N_e = \frac{N}{\cos^3 \alpha}$, should be employed, in order to counteract the flattening and widening effect of the cutter with an angle as indicated above.

* * *

TWIST-DRILL GAGE

A convenient twist-drill gage is the subject of U. S. patent No. 989,857 (April 18, 1911), issued to George Mack, Elliston, Mont. This invention has in view the supplying of a cheaper and more reliable and quickly available gage for twist drills than those now in common use, which are usually inconvenient through having a complexity of parts. The gage is preferably made of a flat piece of sheet metal having a main arm *A* and an oblique arm *B*, the included angle being made as required, which, for twist drills, is preferably 59 degrees. Both arms are graduated arbitrarily or in the standard units, as desired, the graduations on the two arms being so arranged as to project across as indicated by the dotted line *ab*, so that when a twist drill such as that shown at *C* is placed in the gage, it can be seen at a glance whether each side of the cutting face of the drill has been ground down the same distance or not. Also by the oblique scale, it can be determined whether or not the drill has been ground concentric. By this means, the two requisites for a twist drill are easily obtained.



Patented Twist Drill Gage of Simple Construction

* * *

An interesting innovation has been introduced by the Swedish Engineers' Society of Chicago, Ill., in printing its list of members. Opposite the name of each member is printed a small portrait, ⅞ inch high and ⅝ inch wide. This practice may not be suitable for a large society with a membership scattered over a whole continent, but a local society, where personal acquaintance among the members is highly desirable, and the membership comparatively small, would probably profit considerably by such an arrangement of its membership list.

* For further information on the subject, see "A Study in Spirals," April, 1908.

† Address: University of Sheffield, Sheffield, England.

ASSEMBLING OPERATIONS IN THE B. & S. AUTOMATIC SCREW MACHINES—2

By S. N. BACON

An assembling operation which is a little more difficult than that described in the previous article is shown at *A*, Fig. 4. This operation was accomplished in a No. 2 Brown & Sharpe automatic screw machine and consists in making and assembling the socket joint *a* and grooved roller *b*. When in use this grooved roller rides between two tracks as shown at *A*, and the ball part rotates freely in the socket joint *a*. The work was not required to be held to very close limits, and

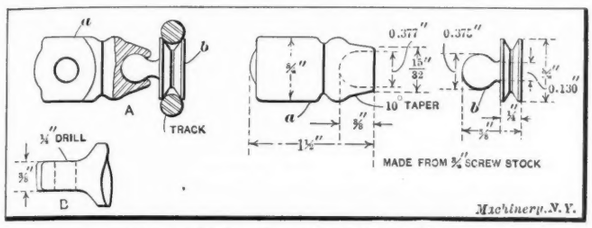


Fig. 4. Pieces to be made and assembled

the milling and drilling, as shown at *B*, were done in separate operations.

In setting up the machine for making the pieces *a* and *b*, the stock is first fed out by hand to the length shown at *A* Fig. 5, where the bar is faced off, and the grooved roller formed; the stock is then fed out to the length shown at *B*

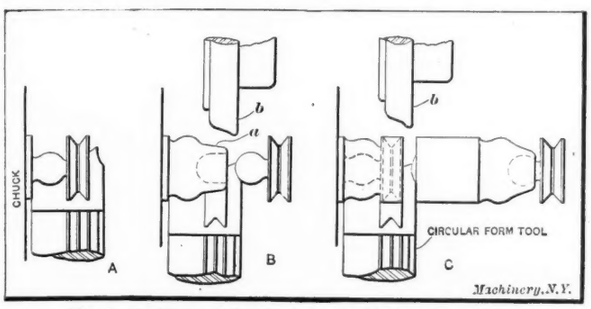


Fig. 5. Positions of the Stock for the Various Operations

where the grooved roller is cut off. When in this position the slotting arm descends, carrying the pick-up shown at *C* in Fig. 6, which grips the grooved pulley, and after it is cut off lifts it out of the way ready to be brought back, when it is to be assembled in the socket joint. While the stock is in the position shown at *B* the hole is drilled and reamed. The reamer, shown at *A* in Fig. 6, is so shaped that it makes a correct seat for the ball on the grooved roller.

The tapered part *a* of the socket joint is formed with a box-tool after the hole has been drilled and reamed. When this

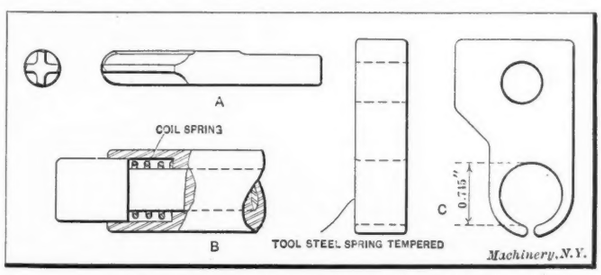


Fig. 6. Reamer, Assembling Tool, and Pick-up

operation is finished, the slotting arm is brought down, carrying the grooved roller, and the spring stop *B*, Fig. 6, which is held in the turret, forces the roller into the socket joint. The spring stop remains stationary in this position, as does the pick-up, while the spinning tool *b*, shown in Fig. 5, which is held rigidly to the rear cross-slide is advanced and turns the nose of the joint over the ball, thus assembling the two parts. When this is accomplished the spring stop is dropped back and the stock fed out against it. The stock is now in the position as shown at *C* Fig. 5, where the completed joint is cut off and the next roller formed to shape, as shown by the dotted outline, which would leave the stock in the same position as at *A*. The operations for making and assembling these two pieces are as follows:

Order of Operations	Revolutions	Hundredths
Feed stock to stop	23	3
Cut off 0.375 inch rise at 0.0021 inch feed	177	23
Cut off and form 0.040 inch rise at 0.0012 inch feed	32	4
Clearance to bring down slotting arm while cutting off piece, take hold of piece and return slotting arm	7	1
Center 0.200 inch rise at 0.0051 inch feed	39	5
Revolve turret	23	3
Turn with box-tool 0.375 inch rise at 0.006 inch feed	62	8
Revolve turret	23	3
Drill 0.387 inch rise at 0.0046 inch feed	85	11
Revolve turret	23	3
Ream 0.387 inch rise at 0.0082 inch feed	47	6
Revolve turret and bring down slotting arm with piece	23	3
Push in piece with holder *B*, held in slotting arm, Fig. 6	(23)	(3)
Spin over end with spinning tool held on rear slide 0.125 inch rise at 0.0054 inch feed	23	3
Withdraw holder and feed stock to stop	31	4
Cut off and form 0.270 inch rise at 0.002 inch feed	131	17
Revolve turret	23	3
	772	100

With a spindle speed of 421 revolutions per minute, it requires 110 seconds to make one piece, which gives a gross production of 327 pieces in 10 hours. The cams for making and assembling the pieces *a* and *b*, Fig. 4, are shown in Fig. 7, where the lobes for performing the various operations are clearly outlined. This was a very interesting job to see

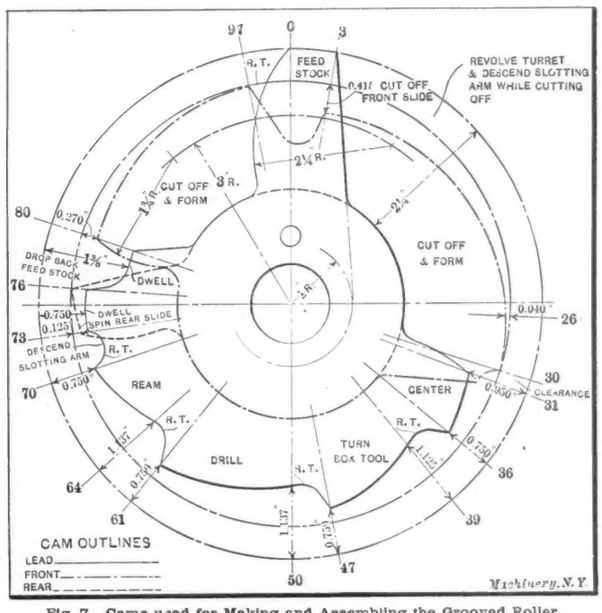


Fig. 7. Cams used for Making and Assembling the Grooved Roller and Socket Joint

running and the saving was much more than would be supposed, because if the parts were assembled as a separate operation it would require a fixture which would be, in reality, a special machine. The advantage of completing the work in the automatic screw machine is, therefore, obvious.

* * *

The steam turbine has caused a complete revolution in German ship-building, according to *Page's Weekly*. It has proved so satisfactory, both in the merchant marine and in the navy, that there are at the present time not less than 42 turbine warships built or under construction. The great efficiency of the turbine engines was shown in the trial of the cruiser *Mainz*, which developed a speed of 28 knots, or approximately 33 statute miles, per hour.

FIXTURE FOR MACHINING STEERING-SPINDLE BALLS

By J. F. BRIGHAM*

The tools shown in the accompanying illustrations, for turning balls, will probably not meet with the approval of any one desiring an extremely accurate ball, *i. e.*, one within a limit of 0.0005 inch; but they were designed for one such as goes on steering spindles of automobiles, where extreme accuracy is not required, a limit of 0.003 inch being considered sufficiently accurate by most designers.

There are a number of ways in which balls of this kind may be made. The most common method is to turn them on a lathe, and while this is good, it requires the use of a 24-inch lathe with a large faceplate and fixture, which, when running at the high rate of speed required, if not properly guarded, is very dangerous to the operator; also, if not very rigid, it is quite likely to chatter. In one shop that the writer had the pleasure of visiting, they were turning, or rather milling, a ball of this kind on a gear-hobbing machine. The results were fair as far as finish is concerned, but the output was small, and it tied up an expensive machine. In the case of either a lathe or a gear hobber a much more experienced and expensive operator is required than is necessary on a drill press. The writer believes in placing work of this kind where it can be done most cheaply, and to the best advantage. There is always enough work to be done on a lathe, that cannot be handled to good advantage on any other kind of a machine, and therefore he believes that a drill press, provided with tools such as here described, is best suited to the purpose.

It will be noted in Fig. 1 that a ball is being turned on an ordinary 24-inch Cincinnati drill press. Steering spindle *A* is held in place in an ordinary vise provided with machine-steel casehardened jaws *B*, machined to fit the ball-arm.

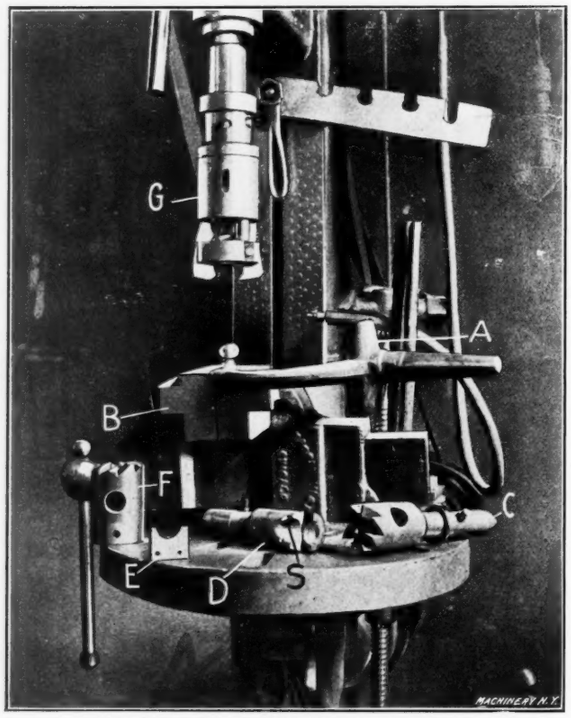


Fig. 1. Fixture used on the Drill Press for Turning Tops of Steering-spindle Balls

Tool *C* forms the first operation, milling to size and forming the top of the ball. This tool consists of three parts, *D*, *E* and *F*. *D* is a machine-steel body with a shank turned to fit a Wizard quick-change chuck, and milled out on the center line at its opposite end, to take cutter *E*. Cutter *E* is held by two straight pins and two ⅜-inch headless set-screws, to take up the variation in width which is caused by sharpening on the face. *F* is a hollow mill which fits over body *D* and is used to mill the diameter of the ball, being held in place by a No. 6 taper pin. The large hole inside of the cutter is for the cutting compound and for cleaning out the chips. *G* is a tool for forming the lower half of the ball; this can be seen to better advantage in the detail drawing, Fig. 2.

This tool, although simple in construction, does remarkably good work. The shank or body *A* is made of machine steel, turned at one end to fit the Wizard quick-change chuck. Two ½-inch slots are milled along the center line on opposite sides, at a 30-degree angle, to fit cutters *B*, so that by pressing down on the hand lever the cutters close around the ball, thus completing the operation. There are two small set-screws provided with lock-nuts that act as stops and set the cutters to the proper size. The cutter shank *C* is turned to ¾ inch, and is a close slip-fit in *A*. It is bored out on the opposite end to fit over the ball, and also acts as a steady-rest for the cutters. It will be noted that there are two plugs with springs back of them to force the cutter shank down. The least upward movement of the hand lever will force the cutters away from the work. *C* is held in place by a ⅜-inch pin pressed into the shank and fits in an elongated slot in *A*. The cutters *B* are made of high-speed steel and are held in place by ⅜-inch hardened pins. These tools have worked out very satisfactorily, and by using a little judgment a man is capable of turning out 150 steering-spindle balls in one day.

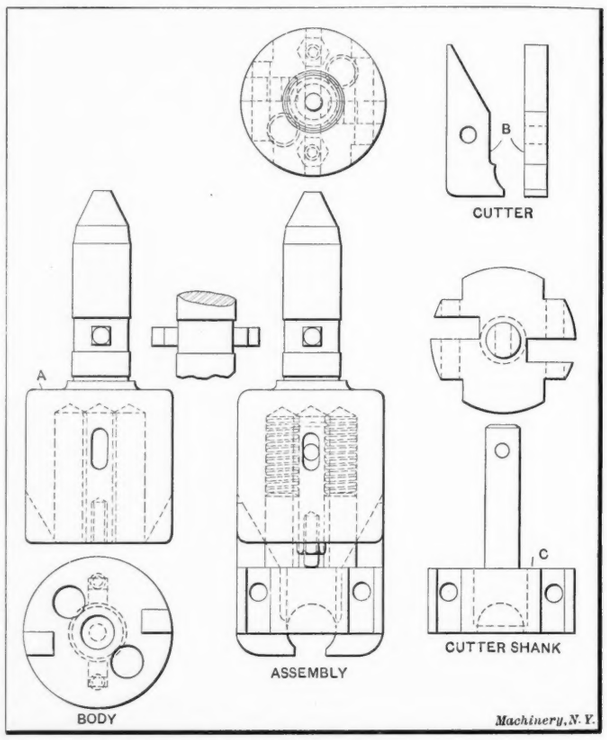


Fig. 2. Details of Fixture used on the Drill Press for Turning the Lower Part of Steering-spindle Balls

* * *

The British Board of Trade has recently issued some interesting statistics relating to the leading industrial countries in the world, giving, in percentages of the total working population, the number employed in eight of the principal occupations or industries. From these statistics it appears that the metal-working industries employ a greater percentage of all workers in the United Kingdom than in any other country. Next in the list comes Germany, then Belgium, then France, and in the fifth place, the United States. The percentage of men employed in the transportation and postal service is greater in the United Kingdom than in any other country, the United States occupying the second place. Thirty-five per cent of all workers of the United States and Germany are engaged in agricultural pursuits, and in all the other leading countries, with the exception of the United Kingdom and Belgium, the percentage is even higher. Of all industries, therefore, farming is, and will undoubtedly always remain, the most important.

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TOOLS AND METHODS USED BY THE SPRINGFIELD MACHINE TOOL CO.

A number of interesting tools and methods used in the shops of the Springfield Machine Tool Co., 631 Southern Ave., Springfield, Ohio, are illustrated and described in the following article. Some of these methods are unique, and all of them are an indication of the attention and care that are given to the accuracy of the resulting product, as well as to the rapid and convenient handling of the work while passing through the various shop operations.

Method for Milling T-slot in Shaper Ram

An unusual method is employed in this shop for producing the circular T-slot in the face of the shaper ram of the shapers

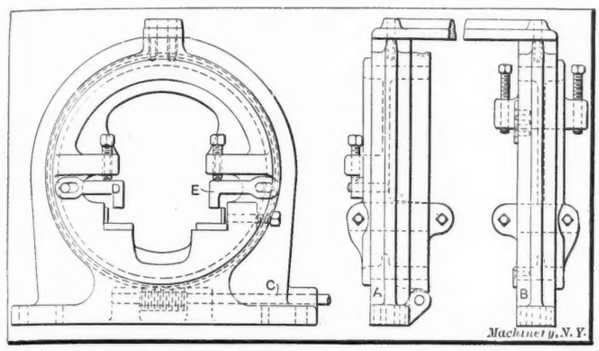


Fig. 1. Device for Milling T-slot in Face of Shaper Ram

built by the company. Ordinarily, this T-slot is turned in the lathe, the ram being supported by a steady-rest at the end where the cut is to be taken. This is a slow method, and unless very carefully carried out, is not always conducive to the highest accuracy; nor does the twisting strain set up in the shaper ram have a very beneficial effect on it, as cases are known where the turning operation has produced a permanent set in the ram.

For these reasons a method of milling the T-slot in the face of the shaper ram has been adopted, the device used for this operation being shown in the line engraving Fig. 1. The face of the ram is cast solid, without coring a groove as is usually done. The T-slot cutter by which the slot is cut is sunk into the metal to the required depth, after which the ram is rotated

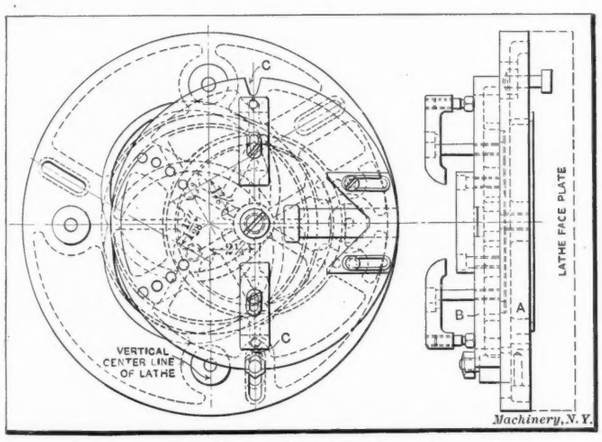


Fig. 2. Device for Hollow-milling Gear Cases shown in Fig. 4

in the fixture in which it is held. As will be seen from Fig. 1, the device consists of two frame castings *A* and *B*, each containing a ring which is free to revolve in the casting. The ring in casting *A* is provided with a worm-wheel, and is given a circular motion by operating the worm-shaft *C* by means of a crank, not shown. Clamps *D* and *E* are provided for holding the ram securely, these clamps binding upon the ways. A strap is used to hold the two frame castings together at the top, and at the bottom they are bolted to the milling machine table. The method has proved rapid and accurate, and presents none of the difficulties met with when these T-slots are turned in the lathe.

Universal Jig for Drilling Gear Cases

In Fig. 2 is shown a jig for drilling gear cases in the lathe. The gear cases to be drilled are of the type shown in Fig. 4, and three sets, each having a different center distance, can be drilled in this jig. As each set consists of three covers for three different gear ratios, as shown, nine covers in all are drilled in the jig. The design of the jig, to accomplish this result, is rather ingenious. It consists of a faceplate *A*, Fig. 2, held on the regular lathe faceplate by means of a circular tongue and groove and four bolts. This secondary faceplate, which is shown in detail in Fig. 3, has mounted upon its face a third plate *B*, which, in turn, holds the work to be drilled. Plate *B* has a circular tongue on its inner face, and plate *A* is provided with three sets of circular grooves as shown in Fig. 3, so that *B* can be placed upon it in any of three positions, each position corresponding to one set of center distances between the holes to be drilled in the gear cases. Plate *B* is held to plate *A* by a screw at its center, three holes, one for each of the three positions, being therefore provided in plate *A*. Two notches *C*, 180 degrees apart, are cut in plate *B*, so that when one of the two holes in a gear case has been drilled, the plate can be indexed around 180 degrees and the other hole drilled.

From this description of the construction of the device, its action and operation will be easily understood. Assume that gear cases with a center distance of 4½ inches, as shown in

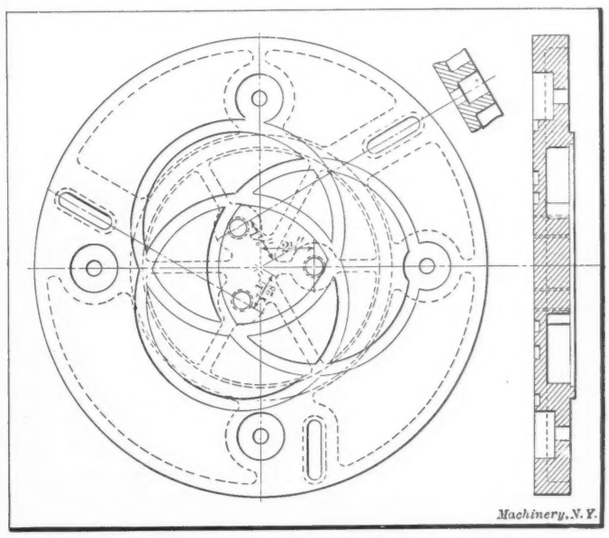


Fig. 3. Secondary Faceplate of Device shown in Fig. 2

Fig. 4, are to be drilled. Half of this center distance is 2¼ inches, and the plate *B* is, therefore, attached to plate *A* by means of the hole which is located at a distance of 2¼ inches from the center of plate *A*, which latter center coincides with the line of centers of the lathe. The index pawl is placed in one of the notches *C*, and tightened, and the gear case clamped to plate *B* by the clamps provided. It will be seen in Fig. 2 that these binding and locating clamps are so made that they will locate the gear case in the correct position to be drilled, and also that means are provided for adjusting the locating points and the clamps for the three types of gear cases shown in Fig. 4. When the gear case is clamped as described, one of its holes will be exactly in the line of centers of the lathes, and this hole is then hollow-milled and the boss faced. The plate holding the work is then indexed 180 degrees, and the other hole is hollow-milled and this boss faced. The bosses on the inside are also faced. As the distance between the center of revolution of plate *B* and the lathe center is 2¼ inches, it is evident that the distance between the two holes drilled will be twice this, or 4½ inches, as required. If the gear case having a center distance of 3¾ inches were to be drilled, the plate *B* would be attached to plate *A* by the hole located 1⅞ inch from the center of *A*. The procedure would otherwise be the same.

Jigs for Holes in Lower Part of Steady-rest

In Fig. 5 is shown the lower part of the steady-rest used on the company's 18-inch Ideal lathe and 18-inch standard

engine lathe. In Fig. 6 is shown a drill jig used for drilling the holes in this part. It will be seen that there are holes to be drilled in both directions for the two jaws and their adjusting screws, one hole for the clamp screw at the bottom,

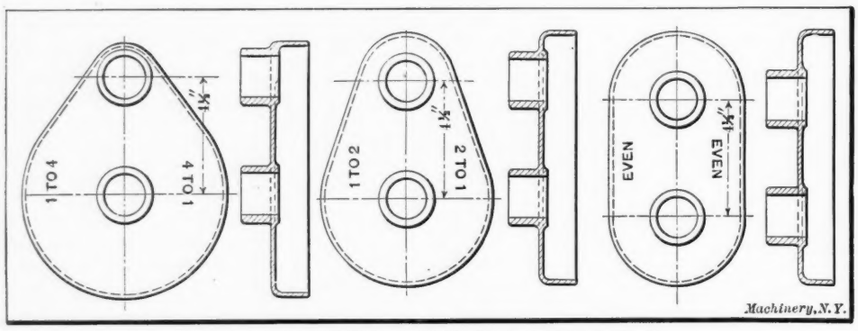


Fig. 4. Gear Cases Hollow-milled in Device shown in Fig. 2

and four holes, in total, from the sides. As the center lines of the holes for the jaws and adjusting screws and for the clamp screw form angles of 60 degrees with one another, the jig was made of a hexagon shape, holes being drilled from five of the six sides. This facilitates the handling of the jig, as it is not necessary to lift it when moving from hole to hole, but merely to roll it on the drill press table, drilling the holes in the most convenient order. The jig is first laid on its side, and the horizontal holes are drilled. Then it is raised up onto one of its hexagon sides, and the holes of the same size

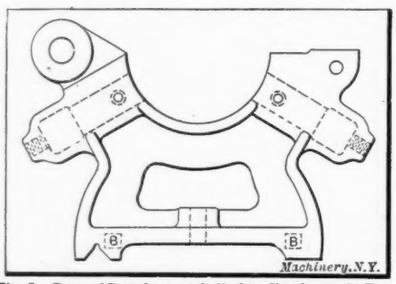


Fig. 5. Part of Steady-rest drilled in Jig shown in Fig. 6.

are drilled at the same time. While this requires rolling the jig over and then back again for the other holes, this presents no difficulty, as the jig, although heavy to lift, will roll over its corners very easily.

It will be seen in Fig. 6 that the work is located in the jig on a V and a flat surface exactly as it will be located on the lathe shears when in use, and that clamping fingers and lugs are so placed as to hold the work securely without springing it. The large clamping bracket *A* has a three-point bearing, insuring a balanced clamping action. Lugs are provided on the work at *B*, Fig. 5, to locate against finished studs *C* in the jig. These lugs on the work are removed afterward. The hexagon sides of the jigs at the top are partly cut away in order to permit the end of the drill spindle to enter the jig, thus shortening the length of the tools required.

Fixture for Planing Tailstocks

In Fig. 8 is shown the general outline of the upper part of the tailstock used on the company's 14-inch Ideal and standard engine lathes. In Fig. 7 is shown a fixture used on the planer for planing the bottom surface and ends *A* and *B*, Fig. 8, of the tailstock. This fixture is rather out of the ordinary in its design. It is conducive to a high degree of accuracy, and at the same time makes it possible to finish the work at a rapid rate. As indicated in the engraving Fig. 7, ten pieces are planed at once, the total length of the

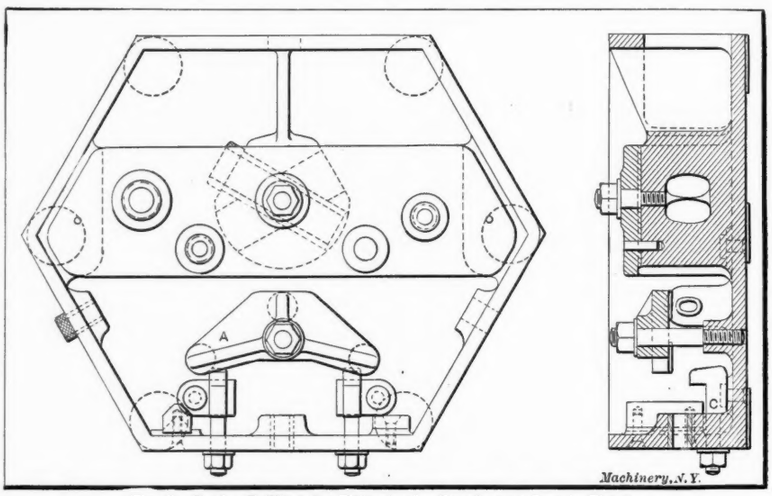


Fig. 6. Jig for Drilling the Holes in the Steady-rest Part in Fig. 5

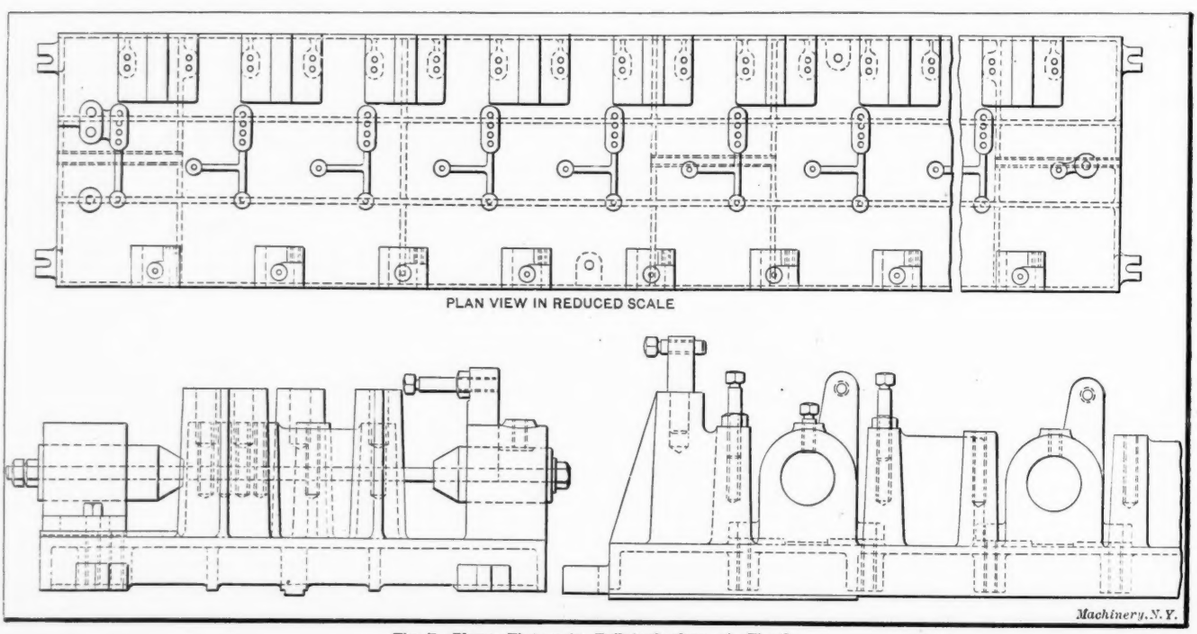


Fig. 7. Planer Fixture for Tailstock shown in Fig. 8

fixture being slightly over 10 feet. The tailstocks are located by the holes for the tailstock spindle, on cone centers, as shown, and are prevented from swinging sidewise by the square-headed set-screws, which can be adjusted to the different heights that may be called for by small differences in the castings. The fixture has a wide range, as it takes care of the tailstock for three different sizes of lathes—from 14- to 24-inch—provision having been made for changing the location of the clamping screws to suit the different sizes.

Drilling and Boring Fixtures for Gear-boxes

In Fig. 9 is shown the feed gear-box used on the company's 14-inch standard engine lathe. In Figs. 10 and 11 are shown the fixtures used in drilling and boring this gear-box. The baseplate shown in Fig. 10 is used for all sizes of the feed

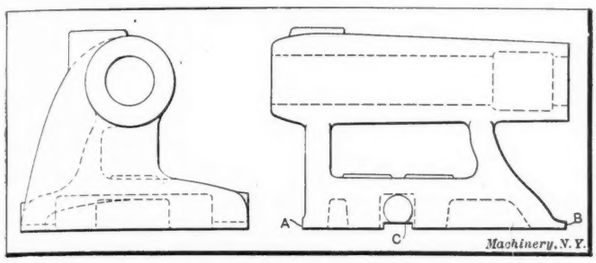


Fig. 8. Upper Part of Tailstock planed in the Fixture shown in Fig. 7

gear-boxes, but the main jig in Fig. 11 must, of course, be different for each size of lathe. The drilling and boring is done on a radial drill, and the baseplate in Fig. 10 is clamped onto the vertical side of the box-table of the machine. The jig in Fig. 11 is mounted on the baseplate by means of hole *A*, Fig. 11, which fits the projecting stud *B*, Fig. 10. The jig is thus free to swing about the stud in the baseplate, and when in operation, this makes it very convenient to use, as the holes from one end can first be drilled, and then the jig swung around and the holes drilled from the other end.

When in use, the cycle of operation is as follows: The gear-box is first clamped in place in the jig before it is mounted on the baseplate. It is located against the stops

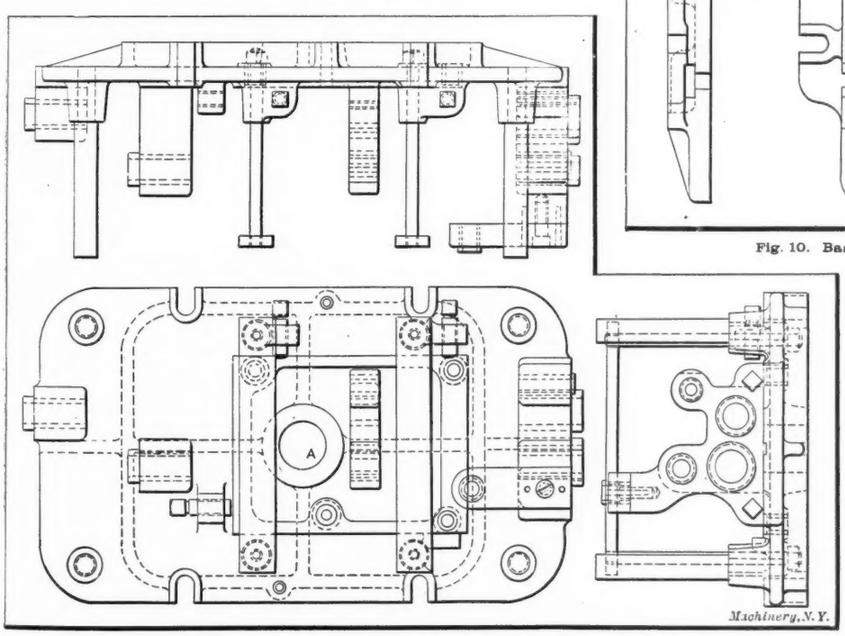


Fig. 11. Jig for Drilling and Boring Feed Gear-box in Fig. 9

in the main jig casting, and clamped by the bar clamps shown. Then the four holes *A*, *B*, *C* and *D*, Fig. 9, are drilled with the jig resting directly on the drill press table. Hole *E* is also drilled, but is finished later with a butt mill. As soon as these operations are completed, the jig is put onto the stud in the baseplate, it being located in the exact position by a taper dowel pin, and clamped by four T-bolts. The two holes at one end are now drilled, and then the jig is indexed around 180 degrees on the center stud, and the four holes at the other end are drilled. Such holes as require reaming are, of course, also reamed. A hole is provided on

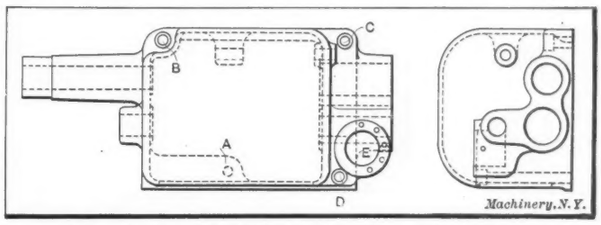


Fig. 9. Feed Gear-box drilled and bored on the Jig in Fig. 11

each side of the jig for the taper dowel pin, so that the jig can be easily located after having been indexed around.

Jigs and Fixtures for Friction Parts

In Fig. 17 is shown the friction driving device used on the 18-inch Ideal lathe built by the Springfield Machine Tool Co. In Fig. 12 are shown the more important parts used in this friction, together with an assembly view, and in Figs. 13 to 16 are shown some of the jigs and fixtures used for performing the drilling and milling operations on these parts.

The construction of this friction is of considerable interest. The two halves of the friction are expanded by means of a double toggle-joint, and heavy springs are provided at *C*, Fig. 12, so that the friction is released at once, and there is no

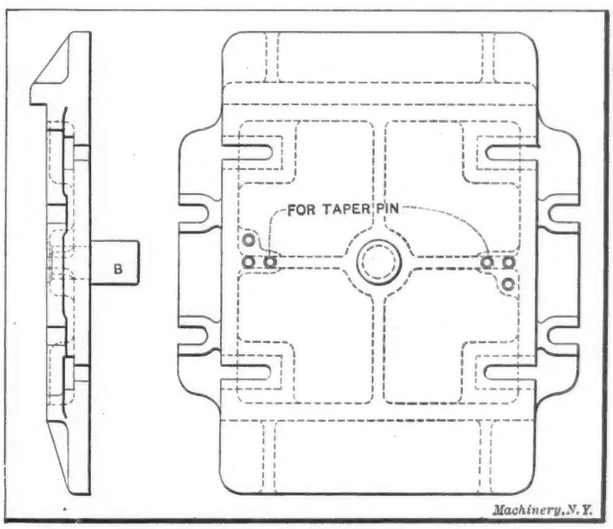


Fig. 10. Baseplate for Jig shown in Fig. 11

dragging of the contact surfaces after the expanding links have been released. The assembly view in Fig. 12, in conjunction with the halftone Fig. 17, gives a clear idea of the simplicity of the action of the mechanism.

The part shown at *A*, Fig. 12, is called the "cone friction shoe," and that shown at *B*, the "face gear friction shoe." There are, of course, two halves to each of these. They are identical in design, except that the face-gear friction shoe is a trifle larger than the other. The jigs for drilling the holes in these shoes are of the same design, and one of them is shown in Fig. 14. The hole at *C*, Fig. 12, is to be drilled and counterbored, and the holes *D*, for the expanding links, are to be drilled and rounded. The work is located and clamped in the jig as shown, and the depth of the counterbored hole in the work is gaged by a stop collar on the counterbore, which comes against the face of the projecting boss at *A*, Fig. 14.

In Fig. 13 is shown a milling fixture for holding the friction yoke shown at *E*, Fig. 12. This fixture is adapted to take three sizes of the yokes, the largest and smallest being indicated by dash-dotted lines in the engraving, Fig. 13. The fixture is used on a No. 3 Brown & Sharpe milling machine, and four cutters in a gang are used to face surfaces *A*, *B*, *C* and *D* simultaneously. The yoke has had its hole drilled and tapped previous to being milled, and is placed on an arbor, threaded at one end and plain on the other, as indicated in Fig. 13. This arbor is then clamped in the fixture between two jaws, clamp screws *E* being provided for locating the yoke sidewise as shown. Screws *F* are provided to prevent any inward springing action of the yoke while the cut is being taken.

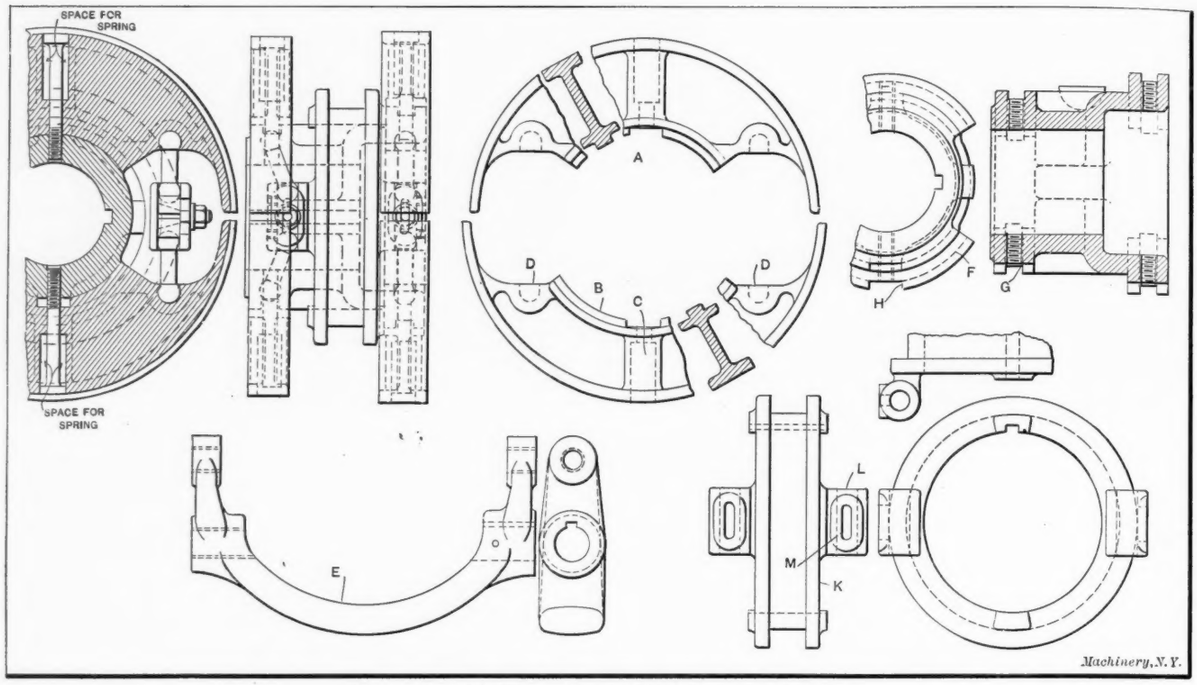


Fig. 12. Assembly View and Parts of Friction shown in Fig. 17

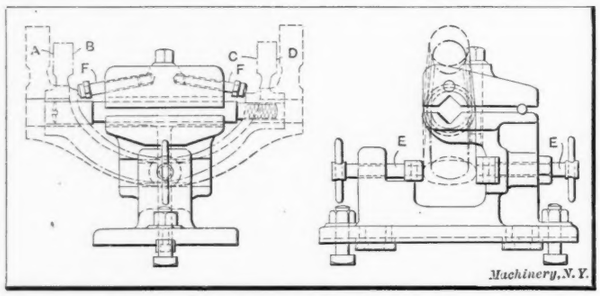


Fig. 13. Milling Fixture for Friction Yoke

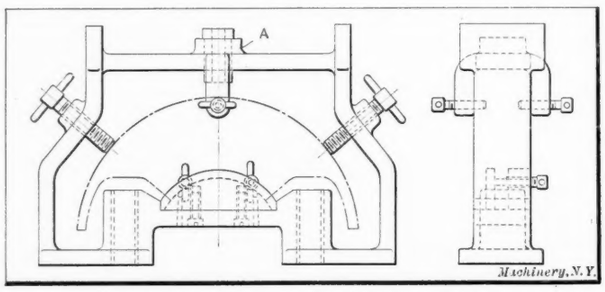


Fig. 14. Jig for Drilling Holes in Friction Shoes

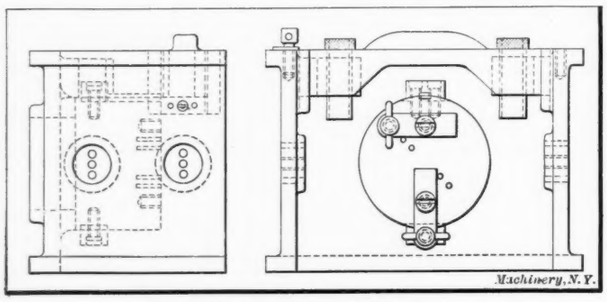


Fig. 15. Jig for Drilling Friction Sleeve

In Fig. 16 is shown a jig for drilling the friction hub shown at *F* in Fig. 12. It is very important that the distance between the screw holes in the hub be correct. The hub is, therefore, located in the jig in such a manner that the groove *G*, Fig. 12, and not the end of the hub, becomes the gaging point. The stud passing through the jig locates the work centrally. The location sidewise, insuring that the drilled holes come exactly in the center of the grooves *H*, Fig. 12, is accomplished by means of a small locating member shown at *A* in Fig. 16, this member being clamped in place by knurled-head screw *B*.

In Fig. 15 is shown a jig for drilling the friction sleeve shown at *K* in Fig. 12. In this jig four holes *L* are drilled from the top, and then the jig is turned over on its side and six holes are drilled, three in each of the two lugs on this side, these holes being used for obtaining the oblong holes *M*, Fig. 12. The jig is then turned over and six holes are drilled similarly from the other side. As shown in Fig. 15, the center stud in the jig, upon which the sleeve is located, is provided with a key, so that the sleeve can be correctly

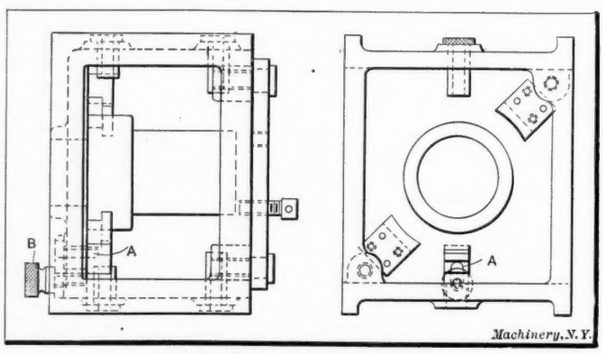


Fig. 16. Jig for Drilling Friction Hub

located by its own keyway. The work is slid in and out of the jig from one of the sides, the clamps by which it is held being of the swinging type, so that they can easily and quickly be turned to one side and then again returned to the clamping position.

The foregoing examples of the tools used in the Springfield Machine Tool Co.'s plant show the general character of the

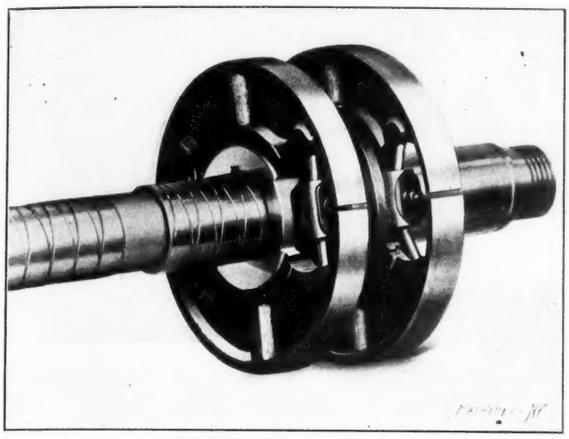


Fig. 17. Friction Driving Device used on the Springfield 18-inch Ideal Lathe

tools and the methods used, and give an idea of the care and thought that are given to the tool designing, at the same time indicating the degree of accuracy and interchangeability which the company aims to secure in its machines.

* * *

THE GEAR HOBBING MACHINE—A FUNDAMENTAL DEFECT

By GEORGE B. GRANT*

The spacing wheel of the hobbing gear cutting machine, on which it depends for accuracy, is at the same time the driving wheel for feeding the blank, and must rapidly wear out of truth.

T. B. Peirce, manager Grant Gear Works, Boston, calls attention to a defect of the gear hobbing machine that I have not seen in print. It appears to be fundamental, that is, not capable of being overcome by invention. Frequent repairing is the only remedy.

The defect has also wholly escaped the notice of the manufacturers of gear hobbing machines, so far as shown by my pile of circular matter. In fact, one of the circulars, with sublime assurance, claims that hobbed work is superior to the ordinary kind in the matter of accuracy of spacing. No such comparison can be made unless the hobbing machine is quite new and the disk cutter machine quite old and out of repair.

Peirce's objection is that the master wheel—the wheel that spaces the work—is also the driving wheel that hauls the gear blank under the strain of the hob while at work, and must wear rapidly.

The manufacturers of another form of gear cutting machine take great pains to show that on their machine the generating mechanism is independent of the cutting mechanism, so that the labor and strain of the cutter as it plows through the metal cannot affect the accuracy of the spacing or the correct form of the tooth.

The lead-screw of the engine lathe is a parallel example, for it hauls the screw-cutting tool into the work and is at the same time the spacing screw on which the accuracy of the work depends. Any inaccuracy of the lead-screw will result in a similar inaccuracy in the screw being cut, and the only remedy is to recut the lead-screw occasionally. The screw milling machine has a decided advantage over the screw cutting lathe on that point; its spacing screw turns very slowly and is used only once while the milling cutter runs the whole length of the work, while the lead-screw of the engine lathe is used as many times as the lathe tool is run over the work.

* Address: Lexington, Mass.

The master wheel of the hobbing machine makes one complete revolution every time the hob cuts around the work once, and that should be every twenty-fifth inch unless the machine is trying to catch up with its "brag" in the matter of output. If two machines, one an ordinary gear cutting machine and the other a hobbing machine, are both cutting gears in stacks six inches thick and with a feed of a twenty-fifth of an inch, then the master wheel of the hobbing machine will revolve one hundred and fifty times on the job and have to haul its work against the cut all the time, while the master wheel of the other machine will revolve once and do no feeding work. The effect on the durability of the spacing wheels needs no demonstration.

The precision required in a master wheel is so great that it must be repaired once in a great while, and it follows that the hobbing machine driving-spacing wheel must be repaired many times in the same period. The hobbing machine master wheel is generally driven by a worm or by a small pinion, and the contact is at a few points only, while the lead-screw of a screw-cutting lathe has a long nut and a surface contact that insures, comparatively, a much slower rate of wear.

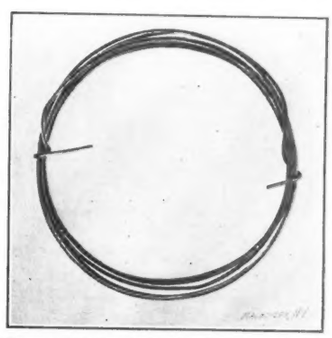
Furthermore, the hobbing machine master wheel must be perfectly tight and true, for any looseness in its fit with its driving worm will show up as flats on the sides of the teeth of the gear being cut. The flats on hobbed teeth are of at least three quite different kinds, those due to the theory of the method, those due to the warping of the hob and to inaccurate sharpening, and those due to the looseness of the train of gearing that drives the master wheel.

Flanders and Lees are exchanging opinions in the columns of MACHINERY. Flanders, better late than never, is showing up the ins and outs, particularly the latter, of the hobbing process, and Lees is defending it. Lees is bound to be defeated and is trying to side-track the discussion by pointedly asking Flanders if the cutter of his favorite gear shaper can be sharpened by grinding without changing its pitch. I am waiting to read what Flanders has to say, and would advise him to say nothing at all, and to remember, in future, that people who live in glass houses should not throw stones.

* * *

WIRE BY-PRODUCT OF DEEP-HOLE DRILLING

The illustration shows a coil of steel wire, 0.020 inch diameter and of uniform section throughout its length of about 30 inches, which is regularly produced in a manner unknown to those unfamiliar with rifle manufacture. The wire is a by-product, being the core left in drilling United States Government Army rifle barrels at the Springfield Armory. The drill used is of the common deep-hole variety having one cutting lip and a vee-slot in one side for the escape of chips, and tube for conveying lubricant under high pressure to the point of the drill. The depth of the vee is about 0.010 inch greater than the radius of the drilled hole and the wire core forms in the point of the vee-slot. The practice of drilling rifle barrels varies somewhat, some experts not being in favor of "drilling with a wire," while others follow the practice of the Springfield Armory in this respect.



Core formed in drilling Rifle Barrels in the Springfield Armory

* * *

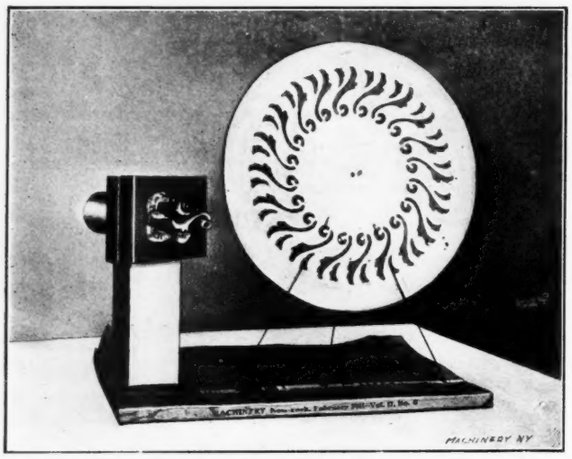
A Practical Problem: Say, cast iron costs three cents a pound, and a mechanic's time, counting overhead charges, is worth forty-five cents an hour. How much profit is there in saving two pounds of metal, if fifteen minutes more is required to machine the casting, because it springs and chatters under a heavy cut?

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY.

A PIERCING PUNCH

The accompanying illustration shows a piercing punch made up of three separate pieces, which were secured in the holder in a novel manner. This was done by pouring type-metal around the base of the punches, and this metal, expanding when cooling, holds them securely. The three parts of the punch were shaped to their full length of 1¾ inch and fitted to the die, small grooves being chiseled crossways about



Three-piece Piercing Punch, secured in the Head by Type-metal

⅜ inch from the inner end, to prevent them from pulling out when punching. The three punches were then inserted in the die and squared up.

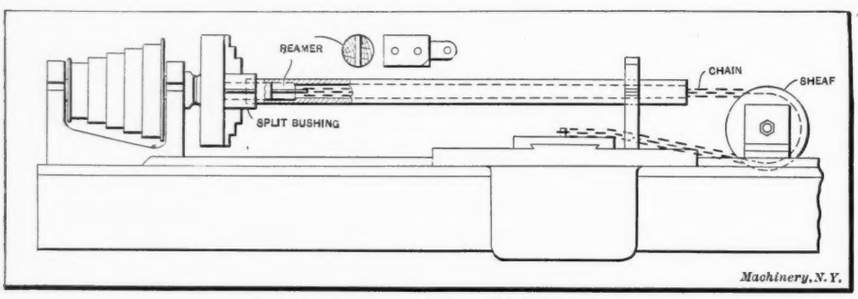
A piece of cast iron about ⅝ inch thick was next drilled out so that it cleared the outside of the punches by about 3/16 inch. The holes were left in the rough with the exception of a slight chamfering to keep the type-metal from slipping out when punching. The cast-iron piece was then packed with parallels and molder's or buffer's sand, and the type-metal poured in.

This punch was used to cut Britannia metal and also German silver and brass disks, but through it all the punches remained solid in their head. A sample of the work produced is shown beside the punch in the illustration.

East Syracuse, N. Y. C. W. SHELLY

CHAIN-DRIVEN REAMER FOR BORING LONG PIPE

An interesting method for boring a cored cast-iron pipe, 2½ inches in diameter and 5 feet long, in an engine lathe, using a very simple equipment, is shown in the accompanying



Chain-driven Reamer boring out Cast-iron Pipe

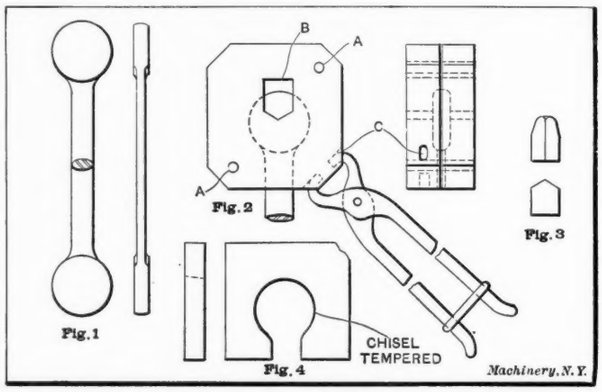
illustration. The pipe was bored by means of the old-style flat reamer, provided with wooden packing on the sides to keep it from chattering and held against the pressure of the cut and fed to it by means of a common link chain.

The pipe to be reamed was gripped in a split bushing held in the chuck and the outer end of the pipe was supported in the steadyrest. The split bushing in the chuck projected beyond the jaws and gripped the end of the pipe only. The inner part of the bushing was bored to the same diameter as the reamer and served to guide the latter into the cored hole. The chain was attached to the reamer and passed through the bushing and cored hole around a sheave mounted on an angle-plate at the outer end, and back to the lathe carriage, to which it was secured. When the lathe was started, the chain twisted until all the slack was taken up, and then the reamer began to operate, being drawn into the cut by the feed of the carriage. It was anticipated that the sand in the iron would speedily cut out the packing and dull the tool, but no such trouble was experienced.

This method of boring cylinders was introduced many years ago in a Western shop and has been in use ever since. A. F.

FORGING WRENCHES WITH A STEAM HAMMER

Mr. Cran's letter on forging wrench jaws in the March number of MACHINERY, brought to my mind a similar problem which may interest some readers of MACHINERY. I had been making double ended wrenches for some time in two dozen lots with 1⅜ and 1⅝ inch openings, respectively, by hand out of 1 by 4-inch soft steel pieces, which were left from another job. This method, however, was not satisfactory, and it was up to me to make them cheaper.



Figs. 1 to 4. Tools used for Forging Wrenches with a Steam Hammer

A blank was made, as shown in the engraving Fig. 1, and filed smooth and to the desired shape; then two pieces of soft steel were taken and hammered out to about 7½ inches square and 2½ inches thick. These pieces were then heated and the blank, Fig. 1, put in between them and hammered together, the blank making an impression in each piece. After working the blank, Fig. 1, into these hot blocks, the edges were brought up with a "bob" punch, and they were then put together for a final blow.

When the pieces were cold, they were taken to the drill press and the blank inserted in them. Then the blocks were clamped together and two ¾-inch dowel holes *A* drilled at the corners (see Fig. 2); through these holes tapered dowel pins were driven tightly into the bottom plate. A hole was then drilled through the top and bottom blocks and the oblong hole *B* chipped out to the proper shape. The hole in the lower block was made sufficiently large to let the punching and punch drop out easily. Two holes *C* were next drilled in the top block to fit a pair of tongues, as shown in Fig. 2, which enabled the operator to handle the upper block easily. The punch shown in Fig. 3 was then made. This was beveled at the top, as shown, and was made perfectly flat and square on

the bottom. Neither the punch nor the dies were hardened, but undoubtedly the punch would last a great deal longer if it were hardened.

The stock for the wrench was hammered out rough and the shank finished as shown in Fig. 1, then chopped off with a circular cutter, leaving nearly the exact quantity required for forming the ends. Some of the forgings, however, had fins on them in some places, so to overcome this a trimming die, ⅞ inch thick and 7½ inches square, as shown in Fig. 4, was made. This die was used in the steam hammer, and trimmed the fins off satisfactorily.

All the operations on these tools, with the exception of drilling the holes for the dowel pins and the hole for the punch, were done in the blacksmith shop, which is conclusive proof of what can be done in an emergency. The dies worked satisfactorily, and over 200 wrenches were produced by them while the writer was employed in that shop, and possibly as many more were put through the dies after he left.

Decatur, Ill. GEORGE COLES

A WIRING DIE

While MACHINERY is full of successful jobs that its readers have accomplished, not much is said of those necessary experiments which lead to the successful accomplishment of the problems in hand; it seems to the writer that it is fully as important to know what can't be done, as what can be.

A short time ago we had to wire a cover, but on account of the smallness of the wire in proportion to the thickness of the metal, considerable trouble was encountered. The material was sheet brass, 0.018 inch thick, and the wiring was 0.075 inch in diameter. The covers were first drawn to the right shape and length of body as usual, in single-action combination dies. Then the usual wiring dies, such as are illustrated in Fig. 1, were made, but their use was not a success, as the covers appeared as shown in the enlarged section; the metal instead of wiring at the top, curled back at the point *a* forming an inner shoulder.

To overcome the difficulty, the punch was bored out, as shown in Fig. 2, and a spring pressure pad inserted to prevent the bottom buckling. While this undesirable feature was eliminated, buckling occurred in the side at the unprotected section, between the pad and the punch, as shown at *b* in the enlarged section, Fig. 2. This, however, gave a clue to the proper solution of the problem, which was to bore out the body of the punch still larger and introduce a pressure pad the full diameter of the inside of the cover. Preparing the punch in this manner, solved the difficulty, and a perfectly wired edge (see the enlarged section, Fig. 3) was produced. These experiments seem to indicate that shell stock under pressure has a tendency to buckle inward and not outward.

Springfield, Mass. C. H. WILCOX

[A sample of the work produced which Mr. Wilcox has sent to this office shows a perfectly wired edge.—EDITOR.]

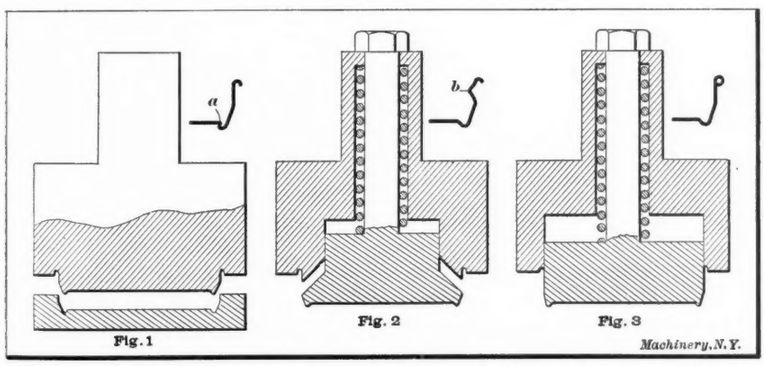
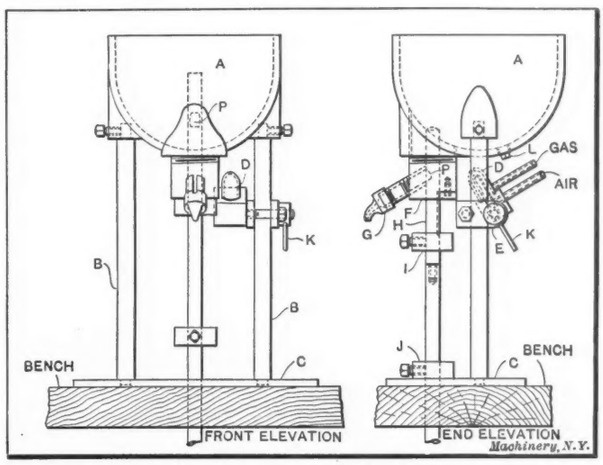


Fig. 1. Usual Type of Wiring Die showing Imperfect Work produced. Fig. 2. Modified Pressure-pad Wiring Die still producing Imperfect Work. Fig. 3 Pressure-pad Wiring Die producing Perfect Work

A SOLDERING DEVICE

The accompanying illustration shows front and end elevations of a soldering device which is very convenient for light manufacturing purposes. This device consists mainly of a pot *A* held to two uprights *B*, the bases of which are riveted to a plate *C*, the latter being screwed to the workbench. Attached to one of the uprights *B* is a burner *D* which is held in a bracket *E*, so that it can be swiveled to any desired position, where it is locked with the wrench *K*. The construction of this burner is clearly shown in the illustration. Screwed into the bottom of the pot is a bushing *F*, into which the nozzle *G* is inserted.

A rod *H* passes up through the bushing *F* and into the pot, and a small groove or pocket *P* is cut in this rod *H*,



An Efficient Soldering Device for Light Manufacturing Purposes

for carrying the solder from the pot down to the nozzle. A slot is also cut in the rear of the rod *H*, and a plate, held on the bushing *F*, fits into this slot and prevents the rod from turning. The size of this pocket governs the amount of solder which will be removed from the pot at each movement of the rod. This rod *H* continues on down through the bench, and is attached to a foot lever by which the rod is operated. The rod *H* is made in two pieces, the upper portion of which can be removed so that various sized pockets which will hold the desired amount of solder can be used. Two washers *I* and *J* are held on the rod *H* by set-screws which limit the travel of the rod.

In operation, the burner is first set directly under the pot, so that the pot is heated and the solder melted. Then the burner is turned on the bushing *F*, keeping it warm, and preventing the solder from cooling in its descent from the pot into the nozzle. A plug *L* is screwed into the bottom of the pot, as shown, so that the solder can be cleaned out, and a ⅛-inch slot is also cut in the nozzle so that it can be cleaned out.

This device will be found very satisfactory, especially for soldering the wires in plugs for electrical purposes. With the ordinary soldering iron, this operation is difficult, as it requires a very small soldering iron to do the work so that the wire will not be burned when applying the solder. Using a small soldering iron means that the wire has to be heated more frequently than with a larger one, thus causing delay and trouble. With this device, the plug with the wire inserted in it is held directly under the nozzle, the foot-lever depressed, and the drop of solder deposited in the desired position without any further trouble. WILLIAM YOUNG

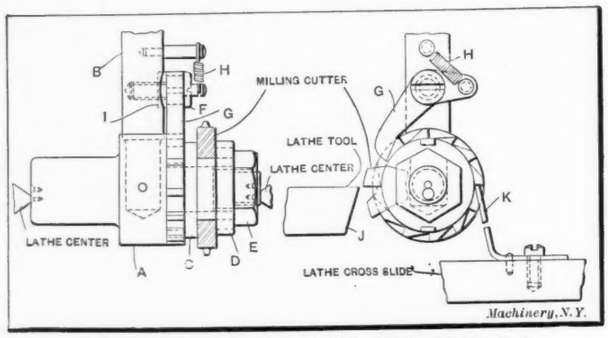
Hartford, Conn.

FIXTURE FOR BACKING-OFF MILLING CUTTERS IN THE LATHE

The accompanying illustration shows a simple device for backing-off milling cutters in the lathe. This fixture consists mainly of an arbor *A* to which is attached a ratchet-wheel and handle carrying a ratchet. The eccentric arbor *A* is free to rotate on the centers of the lathe, and is oscillated by the

handle *B*, the latter being held in a hole in the arbor by a pin. Held against the shoulder of the arbor by a nut *E* is a bushing *C* in which ratchet-teeth are cut corresponding to those in the cutter to be backed-off. The milling cutter is held against a shoulder formed on the bushing *C* by a spanner nut *D*. Attached to the handle *B* by a shoulder screw *F* is a pawl *G* actuated by a coil spring *H*. The shoulder screw *F* rests on a washer *I*, seated in the cylindrical handle *B*.

In operation, the milling cutter is placed on the bushing with its teeth in line with the teeth in the ratchet-wheel, the nut *D* tightened and the bushing placed on the arbor. The



A Simple Device for Backing-off Milling Cutters in the Lathe

bushing should be placed on the arbor with the centers in the same relative position to the cutter as shown in the engraving. As handle *B* is brought forward it carries the milling cutter as well as the ratchet-wheel past the lathe tool *J* held in the toolpost of the lathe, thus backing off the cutter. When the handle is retreated the ratchet-wheel, as well as the milling cutter, is prevented from revolving back by the spring *K* held to the cross-slide of the lathe carriage. Thus it can be seen that the arbor *A* does not make a complete revolution on the centers, but is only oscillated through a space of one tooth, the ratchet-wheel and cutter alone revolving around the centers.

A. F.

UNIVERSAL SHAPER ATTACHMENT

In Fig. 1 is shown an attachment designed by the writer for the special use of toolmakers when accurate work must be performed. An indexing case *A* is attached by a bolt *B* and a nut *C* to the clapper on the head of a shaper, the clapper being indicated by the dotted lines. The clapper must, of course, be rigidly secured in its box by a taper pin

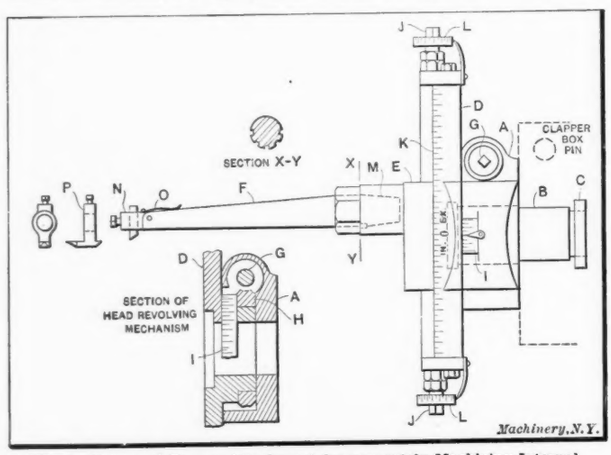


Fig. 1. Universal Shaper Attachment for accurately Machining Internal and External Circles of any Radius

near the lower end, to prevent the tool from jumping. On the front of this indexing head, there is a vertical slide *D*, to the front of which, in turn, is attached a sliding piece *E* which holds the projecting arm *F*. The vertical slide *D* has a circular adjustment to any position by means of the worm *G* and worm-gear *H*, better shown in the sectional view of the head-revolving mechanism in the lower part of the engraving. A graduated circular scale *I*, divided into 360 degrees, shows through an opening in the side of the containing box and has an indicator finger to mark off the number of degrees. When the head *D* is in a vertical position the pointer indicates zero on this circular scale.

The sliding part *E* on the front of the vertical head *D* is fitted to the latter by means of dovetailed grooves which are gibbed in the same manner as those attached to the vertical slide of a lathe or planer head. It is vertically adjustable through the square-threaded bolt *J* engaging with a nut in the sliding member *E*. The side of this vertical head *D* is graduated as shown at *K*, finer divisions being possible through the circular graduation on dial *L* at each end, an indicating finger showing the adjustment.

The tool arm *F* has a taper fit at *M*, in a projection on the front of the sliding member *E*; the section *X-Y* shows the keyways in this taper section, the reason for which will be explained later; this tool arm *F* may be removed from its taper fit by the nut shown. The tool proper is carried in a small clapper arrangement *N* on the outer end of the post *F*, and is retained in its normal position by the spring *O*.

Thus far the description has been purely constructional; the manner in which it may be very serviceably employed will next be considered. A piece *P* shaped as shown is slipped over the end of *N* for setting the tool, the latter being adjusted on the rear ledge of this piece. This piece *P* is so

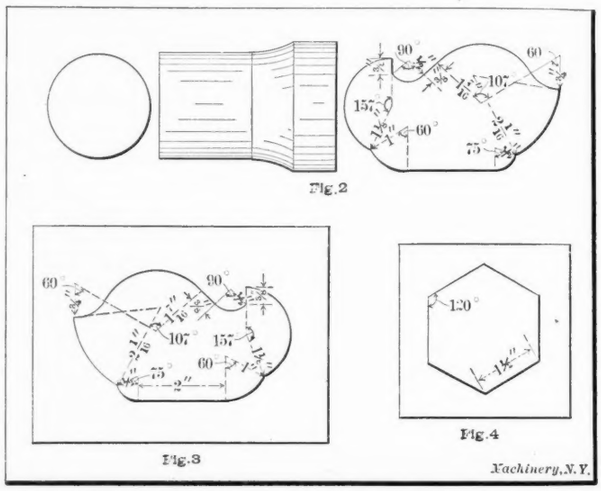


Fig. 2. Punch of Irregular Shape that can be produced readily by this Attachment. Fig. 3. Die corresponding to Punch, also made by Attachment. Fig. 4. Another Class of Work to which Attachment is adapted

made that when the tool is adjusted to its ledge, the tip of the latter will be in the same line as the center of rotation of the vertical slide *D* when the pointer on the scale *I* registers with zero on the scale *K*. The graduations *K* range in both directions "in" and "ex," as indicated. This means that in this position if the vertical head *D* be revolved the tip of the tool will be stationary. If the head *E* be lowered in the direction "in," when the head is revolved the tip of the tool will follow the path of an internal circle; whereas, if the head is raised above zero, the tool will form the part of an external circle.

It will be noticed also that the outer side of the collar *P* has a pointer so that when the head *E* is set to the right radius on the scale *K*, the whole attachment may be adjusted to follow a previously scribed circle on the part to be shaped.

A couple of applications of the use of this head for punch and die work will be shown. Figs. 2 and 3 show a punch and die of an irregular shape made up of circles and tangents; this attachment is peculiarly adapted to such work, inasmuch as it can be revolved through the entire circle, thus dispensing with the time-absorbing feature of resetting the work. As an example of the operation, consider the production of the die shown in Fig. 3. The outline is first scribed as is customary, and the cut-out portion is then roughed out in a drill press in the usual manner. It is then placed in the shaper vise on its lower edge, the two-inch side being first machined. In doing this, the head *D* is placed vertically and the sliding part *E* either set to ½ inch or to 1 inch for an internal curve. Consider it as set for the latter; this means that the head is low-

ered 1 inch. The cut is commenced from the tangent of ½ inch curve to the right for 2 inches, when the cross feed is disengaged and the circular feed by hand through the worm *G* introduced, revolving the head *D* through the necessary 60 degrees which completes that arc. The head is next adjusted for a 1⅛-inch internal circle, and by means of the scriber point of the piece *P* adjusted to take the 157-degree arc which can be nearly completed in this position. For the upright sharp corner, an angle tool must be introduced, when a vertical feed on the shaper head will form the vertical side. For the ½-inch curve the head is adjusted for a ½-inch external curve. The die would be made in a similar manner.

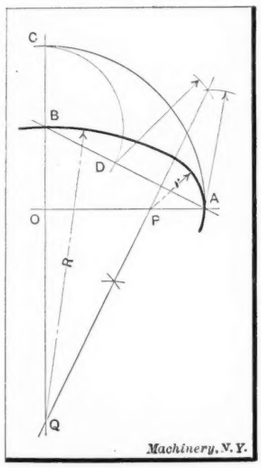
For machining parts such as that shown in Fig. 4 where the sides are straight, the tool bar *F* is adjusted so that its key fits into one of the side grooves shown in section *X-Y*, Fig. 1. The head is then swung over parallel with one of the sides of the cut to be made, when the work can be proceeded with as previously described.

From the description it will be seen that this attachment could also be used on planers, if made sufficiently strong. It is not, of course, intended for heavy cuts or for quick removal of metal, but for the purposes indicated and also for internal gear cutting, its use ought to prove advantageous in shops where special machinery for such purposes is not warranted by the amount of work to be produced. By this method no special milling cutters, etc., are required, as this one set of tools is applicable to all work.

Clinton, Iowa. OLOF N. NORD

"A NEW CIRCULAR-ARC ELLIPSE CONSTRUCTION"

In looking over the pages of the March number of MACHINERY, engineering edition, the writer noticed the article, "A New Circular-Arc Ellipse Construction," by Prof. H. A. S. Howarth, in which is described a method for drawing an ellipse with only two radii. The method is certainly good, but one that is somewhat simpler and almost as accurate may be advantageously used for designing gear wheel and fly-wheel arms. This method is shown in the accompanying engraving and is so simple that an explanation is superfluous.



Circular-arc Ellipse Construction

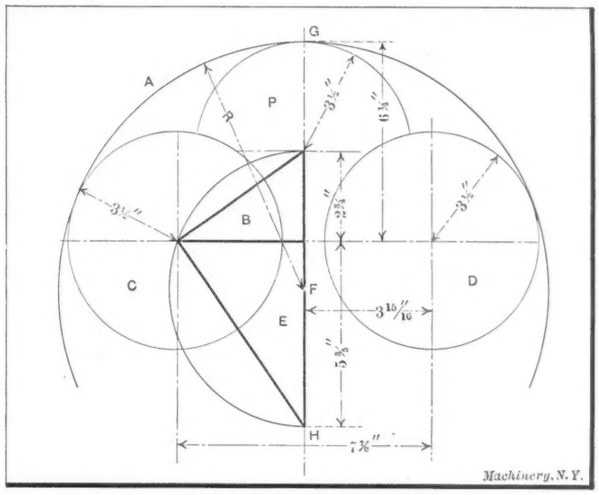
JOHN L. KLINDWORTH
Bellevue, Pa.

[The construction is as follows: With center *O* and radius *OA* draw arc *AC*. With center *B* and radius *BC*, equal to *BO*, draw arc *CD*, cutting *AB* at *D*. With centers *A* and *D*, draw arcs of any convenient size as a constructional means of erecting a perpendicular on *AB* bisecting *AD;* this gives the centers *P* and *Q*. The lines *OA* and *OB* are the half major and minor axes of the ellipse.—EDITOR.]

"SOLVING A PRACTICAL PROBLEM BY SIMULTANEOUS EQUATIONS"

A simple method of solving the problem given by Mr. Howard Terhune under the title "Solving a Practical Problem by Simultaneous Equations," in the January number of MACHINERY, is outlined in the following: The diameter of each of the cylinders *C* and *D* is 7 inches; centers, 7⅞ inches apart, equidistant from the center line of large circle *A*. The distance from the center line of circles *C* and *D* to the top of the circle *A* is 6¼ inches; these figures are those given by Mr. Terhune. It is desired to find the radius of the large circle.

With a radius equal to that of the cylinders *C* and *D*, draw a circle *P* on the line *GH*, tangent to the large circle at *G*, and join its center to the center of the cylinder *C*. By bisecting this line and erecting a perpendicular on it, center *F* of the large circle is located. With *F* as a center draw a semicircle through the centers of *P* and *C*, cutting *GH* at *H*, and join this point to the center of *C*. This produces two right-angled triangles with a common side, and with only one side unknown, this being the vertical side of the triangle *E*, which, by proportion, is found to be 5.638 inches. Adding to this 2¾

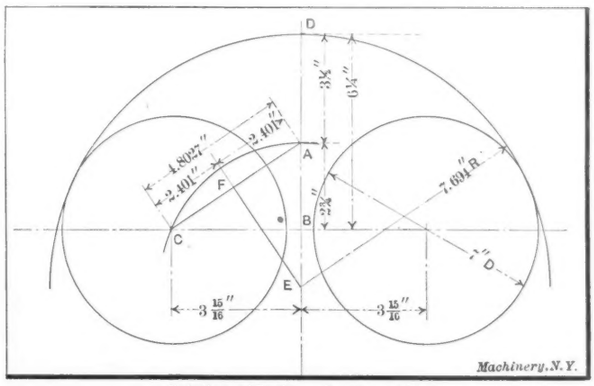


Solution of Problem by Proportion

inches gives 8.388 inches, the diameter of the large circle for a radius of 4.194 inches. The radius of the large circle is obtained from this by adding 3.5 inches, obtaining the answer 7.694 inches. The simplicity of the operation is apparent.

Buffalo, N. Y. JOHN C. STURM

The writer noticed in the January number of MACHINERY, under the title "Solving a Practical Problem by Simultaneous Equations," a very interesting problem by Mr. Howard Terhune, but fails to see where there is anything very difficult about it, for it can be solved by ordinary mensuration. For the benefit of those who might not have a knowledge of simultaneous equations, a solution is herewith presented. It is obvious that if a circle be drawn concentric to the one to be found and running through the centers of the two circles, the line *AD* will equal 3½ inches, and hence *AB* must be 2¾ inches. Now find the hypotenuse of the triangle *ABC* which



Solution of Problem by Proportion

is 4.8027 inches; bisect this hypotenuse *AC* at *F* and erect a perpendicular; this perpendicular will cross a center line at *E*, which is the center of the desired circle. Since the triangles *ABC* and *AFE* are similar, the distance *AE* may be found by proportion, thus

$$4.8027 : 2.75 :: x : 2.4014.$$

Therefore

$$x = 4.194 \text{ inches.}$$

Adding to this 3½ inches, gives 7.694 inches, the required radius. JOSEPH B. ABELE

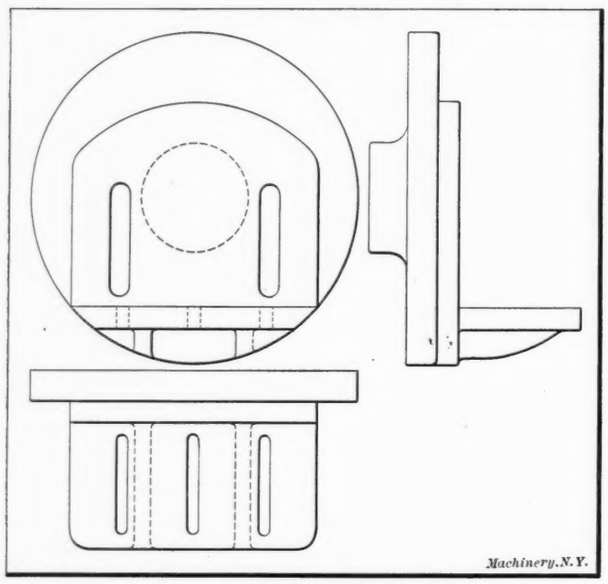
Clifton Heights, Pa.

IMPROVED ANGLE-PLATE FOR LATHE WORK

The article by Mr. C. R. Barton entitled, "Improved Angle-plate for Lathe Work," which appeared in the December issue

of MACHINERY, was read with a good deal of interest by the writer; however, it seems too bad that Mr. Barton did not go a step further and make his plate more useful. In the article mentioned, a statement is made to the effect that with this design of plate no balance weights are necessary; obviously this is incorrect, for no matter what shape the plate assumes, the weight is always off center.

To make the plate of more service, the writer makes it as

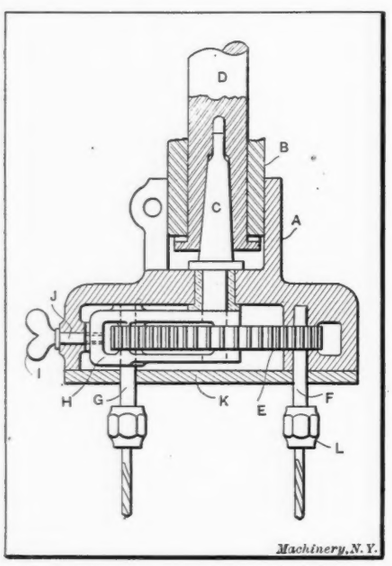


Improved Angle-plate for Lathe Work

shown in the accompanying engraving, which allows the same range as the one described in the previously mentioned article, and at the same time permits of greater width, larger work and more clamping surface. Incidentally, from the design it will be noticed that less balancing is required. P. H.

ADJUSTABLE TWO-SPINDLE DRILLING ATTACHMENT

The attachment illustrated is one that can readily be applied to any standard drill press, for use on jobs in which it is desirable to drill two holes at a time.



Adjustable Two-spindle Drilling Attachment

The construction is as follows: A casting *A* of the shape shown fits over the end of the sliding sleeve *B* of the drill press, and is split on one side and provided with a screw so that it may be securely clamped in position. A taper shank *C* is fitted to a socket in the drill-press spindle *D*. On the lower end of this, within the casting *A* is a large gear *E* meshing with pinions, as shown. Drill spindle *F* on one of these pinions is fixed in position, while spindle *G* on the other pinion is carried on radius arm *H*, which can be clamped in any desired location by means of the screw *I* passing through the slot *J*. Cover-plate *K* is also made with a circular slot to provide for swinging the spindle *G* into the desired position.

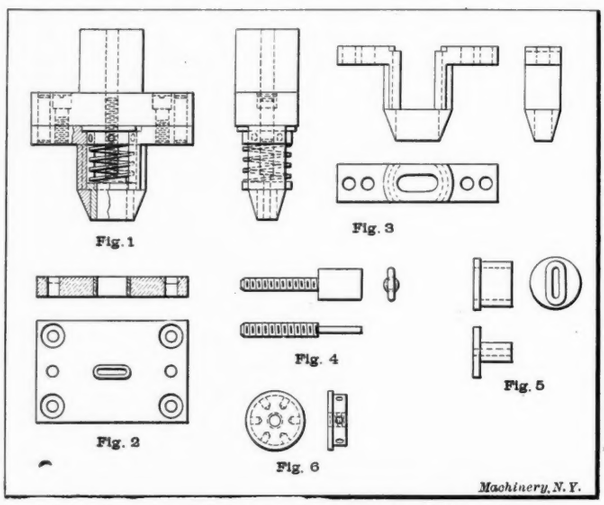
When the two spindles are 180 degrees apart the attachment has its greatest range. The spindles can, however, be brought together to a distance limited only by the size of chucks *L* or the driving pinions on the drill spindles. W. ALTON

PUNCH AND DIE FOR BLANKING AND PIERCING PAPER AND EBONITE

The accompanying illustration shows a simple and efficient punch and die for blanking and piercing ebonite, paper and materials of a similar nature. The blanking and piercing is performed at the same stroke, doing away with the use of a follow die, which is awkward to use on paper, or on ebonite, the latter having to be worked warm.

Fig. 1 shows the assembled punch, and Fig. 2, the die. The die is a brass plate with a center piece of the required size, made from tool steel hardened and driven into the brass plate. The center piece and the hole for it in the brass plate are made with a slight taper so that it can be driven in tight. This center piece is made to fit the piercing punch and is also made small enough on the outside, so that the blanking punch will come outside of it and strike on the brass plate. The die is fastened to a plain bolster-plate by screws and dowels.

The blanking punch, Fig. 3, is made of tool steel, to the shape shown, being bored and turned in the lathe, and the hole for blanking is worked out smooth and parallel. This hole is also lapped parallel after hardening. The blanking punch is attached to the soft steel shank as shown.



Figs. 1 to 6. Assembly and Details of a Punch and Die for Blanking and Piercing Paper, Ebonite, etc.

The piercing punch, Fig. 4, is made to size, hardened and lapped straight and parallel, and the threaded stem is made a snug fit in the hole in the shank, which is bored central with the blanking punch. The circular nut, Fig. 6, is fitted to the threaded stem of the piercing punch and is drilled as shown to permit of turning when the punch is assembled.

The ejector, Fig. 5, is next fitted, the round collar fitting the bored part of the blanking punch, and the other portion of it fitting the inside of the blanking punch proper. The inside of the ejector is fitted to the piercing punch. The ejector is hardened and lapped to a nice sliding fit all over. The spiral spring completes the tool. This spring rests on the ejector and returns it to its normal position after each stroke of the press.

In setting up the die in the press, the circular nut, Fig. 6, is revolved until the piercing punch projects about one-sixteenth inch beyond the face of the blanking punch. It is then easily entered into the die and the tool set up accordingly. When the die is clamped in the correct position, the nut is revolved again, but in the opposite direction, until the piercing punch is almost flush with the face of the blanking punch, leaving it projecting only a few thousandths. The press is set so that the face of the blanking punch just touches the brass plate when at the bottom of its stroke.

It will be seen that in operation the stock is pierced and blanked at the same stroke, the pierced scrap going through the die and the blanks being placed on the face of the die by the ejector. This design of die gives satisfaction, and can be applied to almost any shape of blank with any reasonable number of pierced holes. JETHART

MACHINING THE WRIST-PIN OF A SOLID STEEL CROSSHEAD

In a small jobbing shop with which the writer is connected, an engine came in recently to be overhauled and repaired. The crosshead was the only part that involved any particular difficulty, for, as Fig. 1 indicates, it is a solid steel casting, the wrist-pin being a part of that casting, and not the customary inserted steel pin.

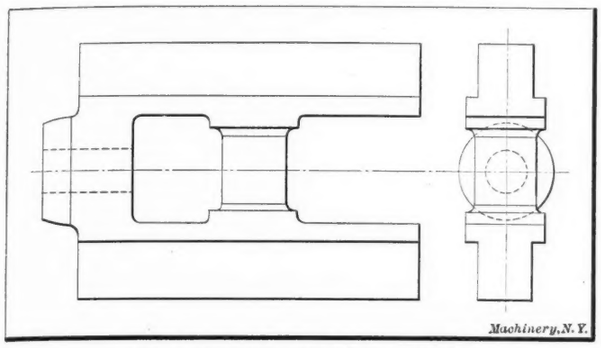


Fig. 1. Type of Crosshead to be machined

The necessary planer work was first performed, during which operation the wrist-pin had flats planed on each side, equidistant from the center of the pin. This is shown by the crosshead in Figs. 2 and 3. The crosshead, with its wrist-pin thus flattened on each side, is centered in the lathe, as shown in Fig. 2 (*A* being the cross-sectional view) and secured there by pins *B* in the faceplate. The half of the wrist-pin toward the open end can then be machined with an ordinary lathe tool, turning the faceplate back and forth through a half revolution by the attached lever. In Fig. 2, the cut is just commencing, the motion being as indicated by the arrow.

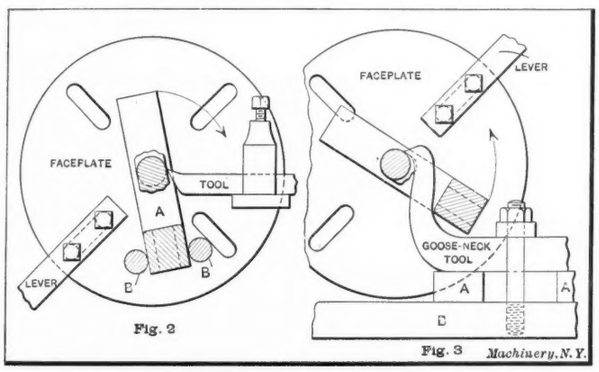


Fig. 2. Machining Open Side of Wrist-pin. Fig. 3. Machining Piston-rod Side of Wrist-pin

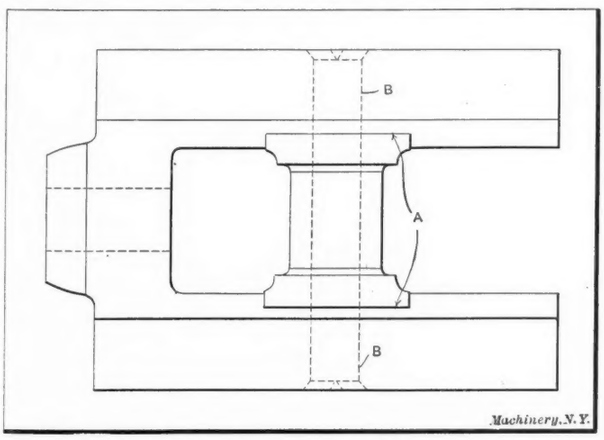


Fig. 4. Method of Repairing Worn-out Wrist-pin by Fitting in a New Piece

A more difficult proposition presented itself in the machining of the piston-rod side of the wrist-pin, because of the confined space. The difficulty was overcome by the method indicated in Fig. 3. The crosshead is left on the centers as before, and a goose-neck tool is employed to do the work, as indicated. The tool was built up on blocks *A* of the requisite height and supported on cross-bridge *B*, bolted to the lathe carriage. In the position shown, the cut has just been completed, the whole requiring to be revolved back half a turn in the direction indicated by the arrow. An equally good way of revolving the piece would be to bolt the turning lever directly to the casting.

Fig. 4 shows a method once employed for repairing one of these crossheads when the pin had worn down too much to be re-turned. The pin was entirely cut out, and grooves such as those shown at *A* were machined; a pin of the shape shown was then inserted, the whole being held together by the long central pin *B*, which was riveted over at the ends to form a solid piece. H. E. WOOD

Newark, N. J.

LATHE ATTACHMENT FOR TURNING CIRCULAR FORM TOOLS

The attachment shown in Fig. 1 is fitted to the bed of the bench lathe directly in front of the headstock, and is used to "generate" the shape of small circular forming tools, such as are used on turret lathes and screw machines. This attachment can also be used for making forming tools of the fly-type used in backing off small gear cutters and work of a similar character. In the average shop, which is not equipped with special or elaborate tools for such work, this attachment will be found valuable, as it can be used for producing the most intricately shaped cutter quickly and at small cost; for instance, without some such device as this, the forming of a cutter for, say, a sixty-pitch gear is a very difficult proposition and, is in fact, impossible to do by ordinary means where very accurate work is required.

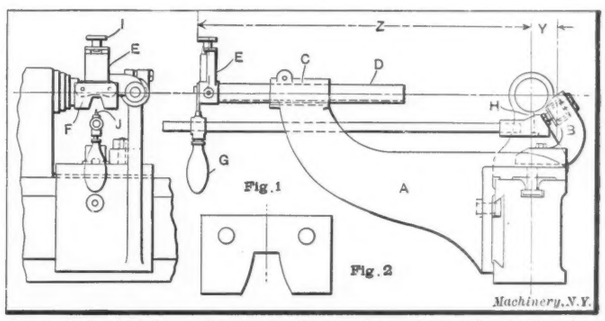


Fig. 1. Lathe Attachment for Turning Circular Form Tools. Fig. 2. Templet or Master Former used on the Attachment

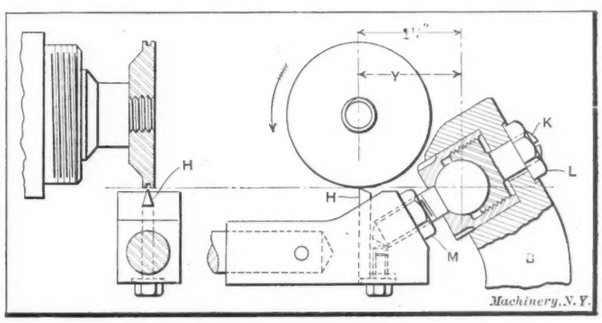


Fig. 3. Enlarged View showing Construction of the Socket Joint—Scale One-half Actual Size

The construction of this attachment is shown in Fig. 1. Here the projecting arm *A* is shown bolted to the bed of the bench lathe, and upon this is fastened the fulcrum support or tool-holder *B*. The outer end of the projecting arm *A*

is provided with a clamp nut *C*, sliding through which is a rod *D* carrying an adjustable templet-holder *E*. The templet or former *F* is attached to this holder by screws. By sliding the rod *D* in and out of the arm *A*, the ratio between the distances *Y* and *Z* can be changed, or in other words, the dimensions on the cutter being formed can be reduced in the desired ratio to that of the templet. To obtain accurate results with this attachment, it is necessary to observe carefully that the center of the ball fulcrum, the cutting tool and the tool guiding point *J* are all exactly in line. If this is not the case error is likely to result, unless the handle *G* is held in a vertical position throughout the operation.

To illustrate the use of this attachment, take a practical example: Assume that it is necessary to make a cutter for a sixty-pitch gear. The templet, shown in Fig. 2, is laid out with the dimensions twenty times as large as those required on the finished cutter, on a piece of 1/16 inch sheet steel, as accurately as possible. Of course, the greater the accuracy of this templet, the more accurate will be the cutter produced; however, dimensions within 0.002 or 0.003 inch are close enough for all practical purposes, as this error would be reduced twenty times on the finished cutter.

In operation, the templet, Fig. 2, is fastened to the holder *E* as shown, and the rod *D* is so set that the distance *Z* is twenty times the distance *Y*, which in the construction shown in Fig. 3 would be twenty-five inches. Having previously mounted the cutter blank on the arbor in the lathe spindle, as shown in Fig. 3, the cutting tool *H* is set to the correct height. The templet *F* is then run down by manipulating the screw *I* (Fig. 1) until the tool will not take a cut from the blank, when the handle *G* is operated, and the point *J* kept in contact with the templet. Then when the tool is set so that it takes a light cut, the direction of the screw *I* is reversed, and the templet raised. The feeding of the screw *I* is continued until the desired shape is obtained on the work. The correct size of the blank can be obtained by means of an ordinary micrometer. The construction of this attachment is more clearly shown in Fig. 3, which shows a section of the ball-socket joint. The details of this are clearly shown and will not need description, except that it may be well to mention that the screw *K* is tightened until the ball does not move too freely in the socket; when this is tightened to the desired tension, the nut *L* is then tightened. A nut *M* is also provided on the shank of the ball, so that the distance *Y* can be changed if so desired. To the right of the illustration is shown the position that the point of the turning tool should have in relation to the form on the circular tool, when setting.

C. T.

IMPROVED FORM OF MILLING MACHINE VISE

In designing milling machine fixtures for milling small light pieces, occasions often arise when it is preferable, from the point of economy, to use jaws of suitable shape, which can be attached to a standard vise, for holding the work. In this case the initial expense for fixtures is merely the cost of a pair of simple, removable jaws and a suitable cutter. On the other hand, a complete fixture for the same job is much more expensive; separate base casting, fixed jaw, clamp or movable jaw, and means for tightening, are required.

A set of jaws has the further advantage of requiring less storage space than would a fixture such as previously mentioned. However, vise jaws as commonly made have one great disadvantage from the fact that the direction of the cut is against the movable jaw. This has necessitated their use on small parts for light cuts only. The form of vise illustrated in this article shows a construction wherein this last objection has been overcome; it is so designed that the cut is against the solid jaw. The design is such that it could doubtless be adapted to many uses, and for that reason is described in detail.

A base casting, which is shown in detail in Fig. 2, is provided with the usual base-tongues for fitting the grooves of the milling machine, and may be clamped either crosswise or lengthwise of the table. For the former, the special clamp shown in Fig. 2 fits into slots *A* in the side of the casting. For lengthwise bolting, the end slots are used. Projections *B* on both sides of the base casting are drilled for 5/16-inch bolts *C*, which hold the stationary jaw face *D*. Recesses *E* in these lugs *B* are formed to receive the block *G*, which is held in place by the cover-plate *H*. This cover-plate *H*, together with the shield *I*, serves the additional purpose of preventing chips from getting into the mechanism. In block

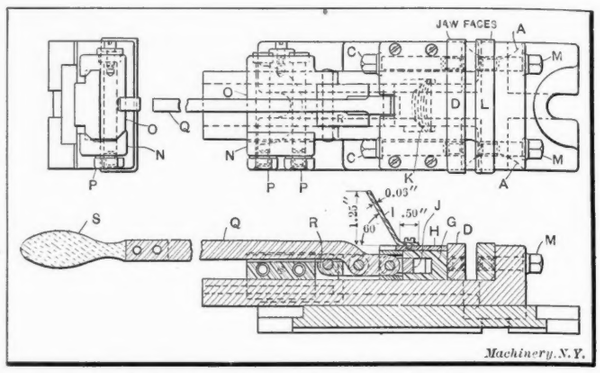


Fig. 1. Improved Form of Milling Machine Vise

G, there is a sliding member *J* which bears up against a spring *K*, the uses for which will be explained later. The movable jaw casting is shown in detail in Fig. 2. It has a jaw face *L* attached to it which is held in position by two screws *M*. Near the rear end of the sliding portion of this movable jaw, parts *N* and *O* are clamped by bolts *P*.

The operation of the vise is provided for by a toggle movement, the two links being *Q* and *R*, which are connected as shown by ¼-inch pins. All these parts are made of hardened tool steel, as most of the wear comes on these members. The link *Q* also serves the purpose of a lever and has a white metal handle *S* attached to it. It can be seen that by raising this handle, the toggle movement will lift, drawing the movable jaw to the right, for the insertion of the work. The heavy spring *K* previously mentioned provides for any inequalities in size in the different pieces of the same lot.

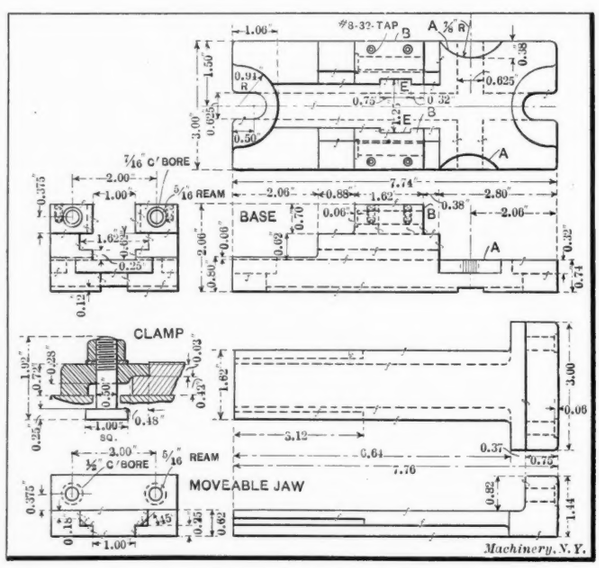


Fig. 2. Important Details of Vise

The jaw faces *D* and *L* can be made to any shape desired to suit the requirements of the piece being milled. The vise has quite a wide range of adjustment by changing the relative location of the jaws by means of the clamped pieces *N* and *O*.

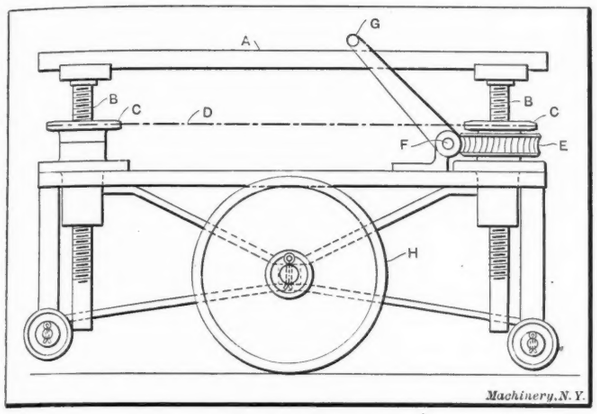
Many of these vises are in use in the shop where this one was built and are giving very satisfactory and efficient service.

DESIGNER

A HANDY SHOP TRUCK

The accompanying illustration shows a strong shop truck which is very convenient for carrying heavy pieces from the machine to the bench, or *vice versa*. As will be noticed, the table can be raised or lowered as desired. This makes it particularly advantageous for rapid production on a machine, as no time need be lost in stooping over and picking up the work.

The construction of the truck is practically self-explanatory from a study of the illustration. A table *A* is supported at its corners by four screws *B*, on each of which there is a sprocket nut *C*, an endless roller chain *D* passing around the



A Handy Shop Truck

four nuts. On one of these sprocket nuts there is a worm-gear *E* meshing with the worm *F* which, in turn, may be driven by the handle *G*, so that the table may be raised or lowered as desired. The main part of the truck, or what may be called the "frame," is supported on two wheels *H*.

The writer has seen a load of as much as four tons on one of these trucks, the screw mechanism being sufficiently strong to lift this weight. Our shops have had trucks of this kind in use for several years, and the results have been all that could be desired.

W. ALTON

IMPROVED CENTERING HEAD

In using the regular centering head which belongs to a combination square it is impossible to draw a line except through the center of the work, and as it is often necessary to lay off a square in the center of a round piece, it would not be

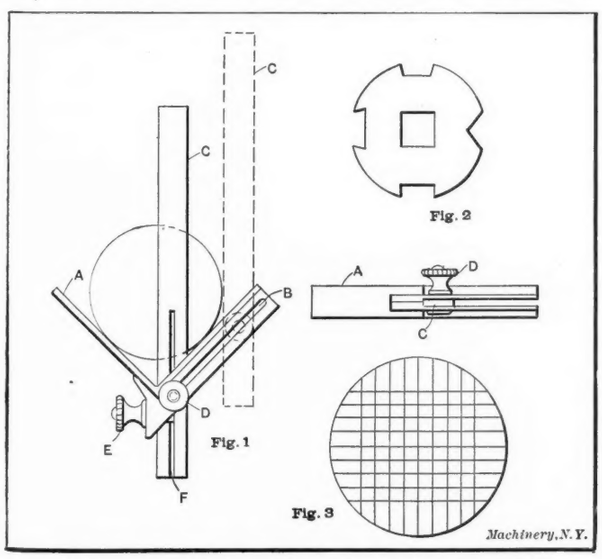


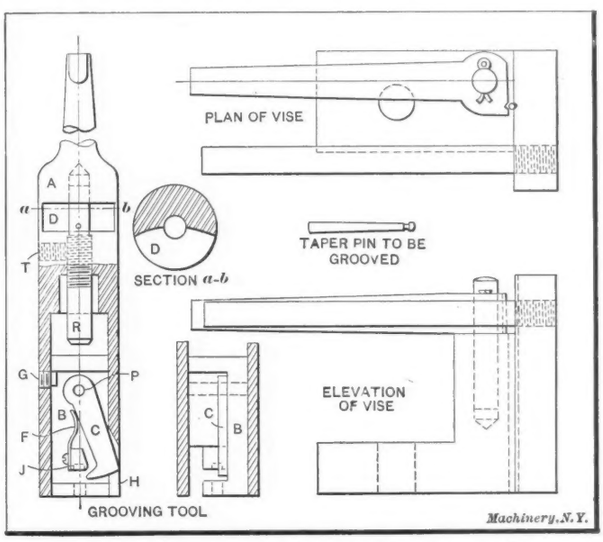
Fig. 1. Improved Centering Head. Figs. 2 and 3. Some of the Possibilities of the Improved Centering Head

possible to do it with the tool mentioned. Having had considerable laying out of this description to do, the writer devised the centering head shown in Fig. 1. This head is somewhat similar in construction to the ordinary combination centering head, but it is adjustable so that the blade can be set in any desired position. In the illustration Fig. 1, *A* is the head, in one arm of which a slot *B* is cut, thus allowing the scale to be set in a central position and also out a short distance from the end of the arm. The scale *C* is locked in the desired position by means of the thumb-nut *D* and when in a central position it is locked with the thumb-nut *E*, the screw in which has a heel on it operating in the slot *F*. This method of locking is the same as that used on the combination square. To keep the blade parallel to the center line, there is a diagonal line drawn on the blade which coincides with the inside face of the head, and the face of the head is also graduated in fractions of an inch. It is obvious that this tool cannot be set exactly parallel with the center line by means of this line drawn on the scale alone, but measurements should be taken from the line or lines previously drawn. In Figs. 2 and 3 are shown some of the possibilities of this head for laying out work. Of course the tool can be made more elaborate to answer other requirements, but the design illustrated herewith has given entire satisfaction to the writer.

San Francisco, Cal. WALTER DE SANNO

PIN-GROOVING TOOL

The tool illustrated was designed to cut the groove around the end of the No. 1 taper pin shown. Pins of this type without the groove are used by us in large quantities, and as on each engine only two of them require to be grooved, it was



Taper Pin Vise and Pin-grooving Tool

unprofitable to have the firms manufacturing the pins groove them as well. The grooved end is used to secure the loop of a coiled spring.

Previous to using this little tool, the operation was performed by securing the pin in a drill-press chuck, and filing the groove—an exceedingly slow method. In the tool under consideration, the body *A*, having a No. 1 Morse taper shank on its upper end, is bored out as shown to receive the block *B*, a coil spring around stop-pin *R* keeping the block in its normal position against screw *G*. The block *B* is of tool steel, turned to fit freely, and slotted to take a ⅛-inch cutter, which is pivoted at *P*, the cutting end of the cutter being rounded to correspond to the groove to be cut. Normally, it is held out in the slot *H* in the main body by spring *F*. Stop-pin *R*, which is threaded, may be adjusted by means of the pin holes exposed in the slot *D* in the side of the body. Set-screw *T* secures the stop-pin where desired.

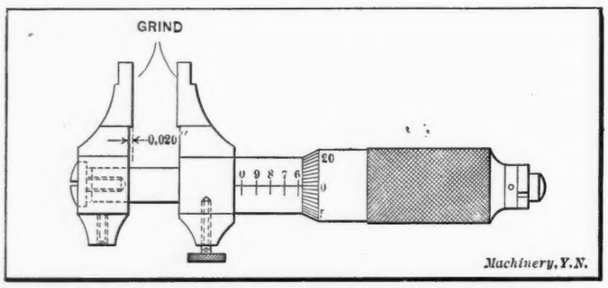
In operation, the tool held in a drill press, is lowered down on the pin held in the special device shown, until the top of the pin strikes stop *J*; further movement of the tool shoves up the block *B*, the cutter *C* striking the taper edge, and entering radially to cut the groove. This cut can be made to a predetermined depth by setting stop-screw *R* as desired, preventing the upward movement of the block.

The vise is casehardened, and the pins are held by V-jaws; the vise is bolted to the drill-press table. A small projection in the jaw supports the pins, but when the handle is thrown back, they drop through the jaws and the table. This makes a quick-acting, positive vise. The speed at which the pins can be grooved is limited only by the time necessary to place the pins in the vise, this being the longest operation.

Freeport, Ill. D. O. BARRETT.

CONVERTING AN INSIDE MICROMETER INTO AN OUTSIDE MEASURING TOOL

Anyone having an inside micrometer can easily convert it into an outside measuring tool, by simply taking off the jaws and grinding the hub end on both of them about 0.020 inch below the outer end or measuring surfaces, as shown in the accompanying illustration. After the jaws have been



Method of Converting an Inside Micrometer into an Outside Measuring Tool

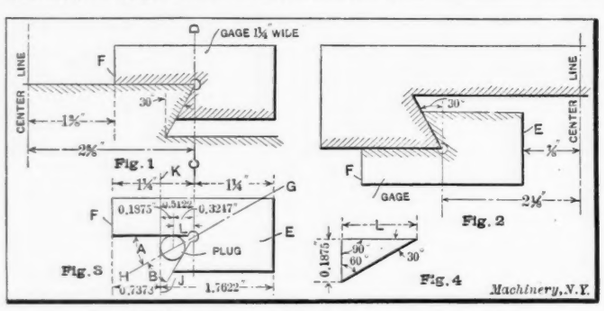
ground they are again assembled and opened wide enough to permit a saucer-wheel to be used for grinding the measuring faces. The face of each jaw is then ground by the saucer-wheel, care being taken not to remove any more material than is absolutely necessary to clean them up. The jaws in the micrometer can then be adjusted to their proper position. This tool will be found very effective for getting into places where an ordinary outside micrometer cannot be used. But, in using this tool for outside measurements it is necessary to subtract the thickness of the jaws from the reading on the thimble to get the desired dimensions.

New Britain, Conn. W. C. BETZ

[There is one serious objection to this change, however, owing to the fact that adjustment for wear can only be provided for in one direction; that is, if the caliper is adjusted to make readings for inside measurements it would show a still greater error when external measures are taken.—EDITOR.]

GAGE FOR MEASURING DOVETAIL SLIDES

Where a number of dovetail slides are to be measured to the sharp corner, and the dimension obtained accurately and quickly, the gage shown in the accompanying illustration can be



Gage for Measuring Dovetail Slides and its Application

used to advantage. As all slides made in our works are 30 degrees, this gage is made to that angle. To obtain the dimension from the sharp corner of a dovetail to the center line as shown in Fig. 1, the gage is located on the slide as shown, and as the gage is made 1¼ inch from the sharp corner, the distance from the sharp corner can be easily obtained by simply placing an ordinary scale against the end *F* of the gage, and measuring the difference between it and the center line. In this case the difference between the end *F* of the gage and the center line is 1⅜ inch, so that the difference between the center line and the sharp corner on the line *C-D* is 1⅜ + 1¼ = 2⅝ inches. The application of this gage to the measuring of the top slide is shown in Fig. 2. Here the dimension is taken from the end *E* to the center line, which is found to be ⅞ inch; then the distance from the center line to the sharp corner is 1¼ + ⅞ = 2⅛ inches.

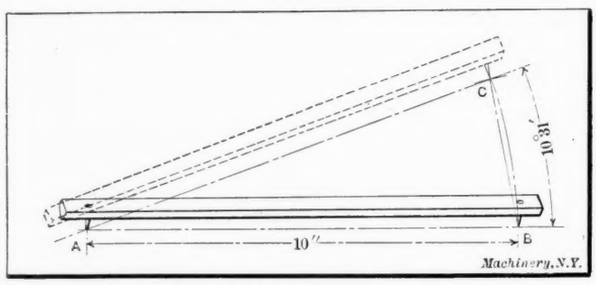
To figure out this gage or one of a different angle, take a plug gage, say ⅜ inch, set it in the dovetail as shown in Fig. 3, and measure the distance from the face of the plug or the line *J-K* to the face *E*. The line *H-G* bisecting the angle of the dovetail, which in this case is 60 degrees, makes the angles *A* and *B* 30 degrees. Then, as the radius of the plug equals 0.1875 inch, we now have a triangle as shown in Fig. 4, where it can be seen that *L* is the distance required. From "the law of tangents" in trigonometry, the opposite side of any right-angle triangle equals the side adjacent multiplied by the tangent of the angle. Then *L* = 60 deg. × 0.1875 = 1.732 × 0.1875 = 0.3247, and 1.250 + 0.3247 + 0.1875 = 1.7622 inch, which is the distance from the face of the plug or line *J-K* to the face *E* of the gage; also 1.25 — (0.1875 + 0.3247) = 0.7378 inch, which is the distance from the face *F* to the face of the plug or line *J-K*. This gage is made about 1¼ inch wide, of tool steel, and the faces *E* and *F* are ground to the correct dimensions.

W. H. VOCKELL

Cincinnati, Ohio.

ACCURATELY LAYING OUT ANGLES

Having laid out property plans for factories and also drawings of machine parts where the angles were required to be drawn very accurately, the writer has found that protractors graduated to read to five minutes do not give sufficiently close results. Employing the old formula, "The sine of half



Simple Device used for Laying out Angles accurately

the angle is equal to half the chord," very accurate results can be obtained by means of the simple device shown in the accompanying illustration. A strip of wood, 10½ inches long, and ¼ by ⅜ inch or ½ inch section, planed perfectly smooth, has two needles forced into it exactly 10 inches apart, the points projecting about ½ inch. In laying out an angle, find the sine of half the angle that is to be laid out; multiply this by 10 (distance between points) and the result will be the length of half the chord.

Example: Lay out an angle of 10 degrees 32 minutes.

Half angle = 5 degrees 16 minutes.

Sine 5 degrees 16 minutes = 0.0917.

Half chord = 10 × 0.0917 = 0.917 inch.

Therefore

Chord = 0.917 × 2 = 1.834 inch.

Place the point *A* at the vertex of the angle with center at *B* and radius of 1.834 inch, draw an arc cutting the arc *B C* drawn by this beam at *C*; joining *A* and *C* gives the angle accurately at any place on the board without the assistance of a T-square.

J. C.

* * *

A man's responsibility for work may end when a job passes his department, but his interest in it should reach a little farther to insure the best results.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW DESIGNS AND IMPROVEMENTS
IN AMERICAN METAL-WORKING MACHINERY AND TOOLS

BULLARD VERTICAL TURRET LATHE

A vertical turret lathe brought out by the Bullard Machine Tool Co., Bridgeport, Conn., is illustrated in Figs. 1 and 2.

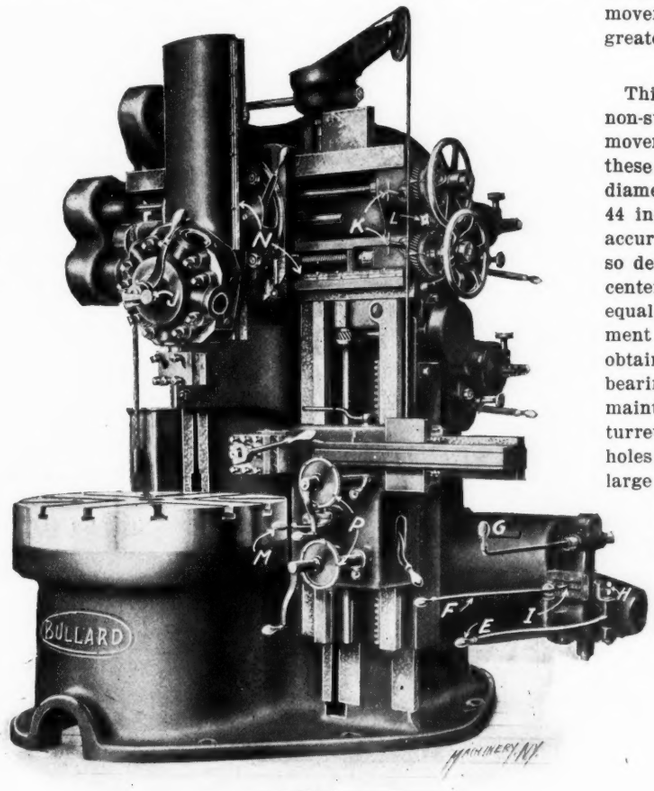


Fig. 1. Bullard 42-inch Vertical Turret Lathe

This machine is nominally a 42-inch size, but has a maximum capacity for stock up to 44 inches in diameter and will take work 32 inches high under the cross-rail. The table is driven through accurately planed bevel gearing and its spindle is of the standard Bullard type, having a large angular thrust bearing and vertical cylindrical bearings of large proportions to absorb the side strain. All the bearings are accurately and concentrically ground on a special machine designed for this purpose, and the entire spindle is immersed in oil which is supplied as will be explained subsequently.

The Speed Changing Mechanism

There are twelve speed changes for the table varying from 3.1 to 60 revolutions per minute. These changes are obtained through two systems of selective sliding gears and positive clutches, located as indicated by the letters *A* and *B*, Fig. 2. A multiple disk clutch is interposed between the main driving shaft and the primary speed change device, and the brake parts are integral with the driven member of this disk clutch. Both the clutch and brake are operated by lever *E*, the engagement of one disengaging the other. Any one of four primary speeds may be selectively engaged by lever *F*, and the secondary speed changes are obtained by lever *G*. By means of a positive interlocking device at *H*, the clutch must be released and the brake engaged before a speed change can be made, and a complete engagement of the gears for any speed is necessary before the brake can be released and the clutch re-engaged. This interlocking device does not interfere in any way with rapid manipulation, but it does serve as a safeguard against breakage due to careless handling. The number of table revolutions per minute can be instantly ascertained from a direct reading indicator *I*. All the controlling levers and handles are centrally located, which eliminates unnecessary movements on the part of the operator and is conducive to greater output.

The Vertical Turret and Side Heads

This machine has one swiveling vertical turret head and one non-swiveling side head, each of which is independent in its movement, both as to direction and amount of feed. Both of these heads can be operated simultaneously on work of small diameter without interference. The vertical head will face 44 inches, and it has a vertical movement of 27 inches. An accurate center stop is provided for the main head, which is so designed that the head can be carried 3 inches beyond the center. The swivel base of the main head has a diameter equal to the full width of the saddle, and an angular adjustment up to 45 degrees either side of the vertical center is obtained by a system of gearing. The turret slide has a broad bearing on the swivel base, and special provision is made for maintaining alignment with the center of the table. The turret is 16 inches in diameter and has five faces containing holes 2¾ inches in diameter. It is set at an angle so that large tools will clear the slide, and one turn of lever *J* indexes the turret from one face to the next. The turret holes have steel bushings which can be replaced readily should wear occur. The shanks of tool-holders, boring-bars, etc., are securely held in the turret holes by half boxes that are clamped against the bushings by the binder bolts shown. As no frictional binder is sufficient to resist the twisting strain caused by heavy cuts, a pin of large diameter, located at the inner end of the turret holes, enters a slot in the bar and acts as a driver. The tool-holder can be par-

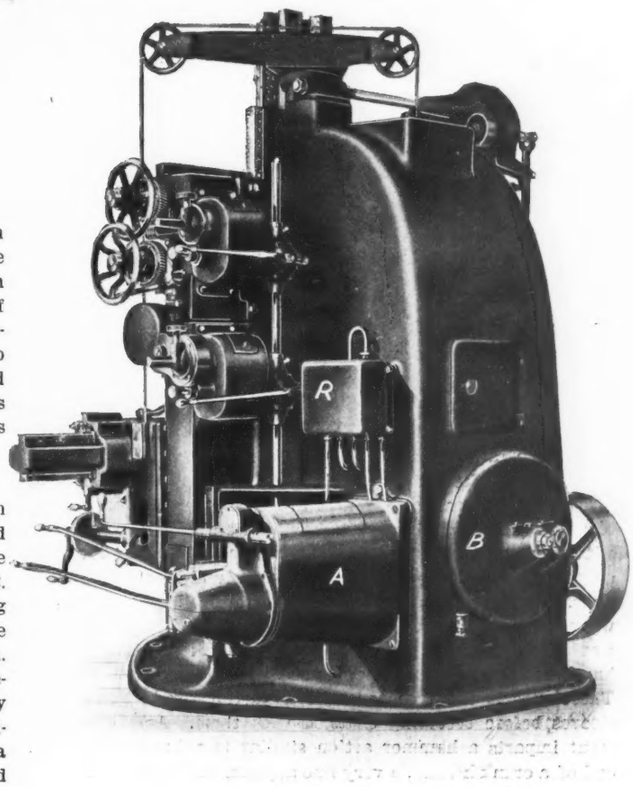


Fig. 2. Rear View of the Bullard Vertical Turret Lathe

tially withdrawn and disengaged from the driving pin to set a tool on the center. The vertical head can be rapidly moved in all directions by power, independently of the feed works or table drive, the control being by handles *K*, which are connected with friction gearing by rods passing through holes in the feed rod and screw. Vertical and cross motion in either direction can be engaged singly and simultaneously, the operating mechanism for each being independent, and a speed device prevents damage from careless handling. The side head has a vertical movement of 28 inches and a horizontal movement of 21 inches. A quick hand movement in all directions is provided and also means for making fine adjustments independently of the feed works. A four-face turret tool-holder on the side head obviates a constant changing of tools.

Feed Mechanism, Micrometer Dials, Stops, etc.

The feeding mechanisms for each head are entirely independent and there are eight changes, ranging from 1/96 to ½ inch in all directions. These changes are quickly obtained by turning the knurled wheel seen on the feed-box, and the amount of feed per revolution is indicated by an index-plate giving direct readings. The feed for the main head is engaged, disengaged or changed from vertical to cross or *vice versa*, by engaging a centrally-located drop-worm *L* with the worm-gears on the end of the feed-rod and feed-screw. The feeding movement for the side head is engaged, disengaged or changed from vertical to cross or *vice versa*, by plunger-lever *M* located on

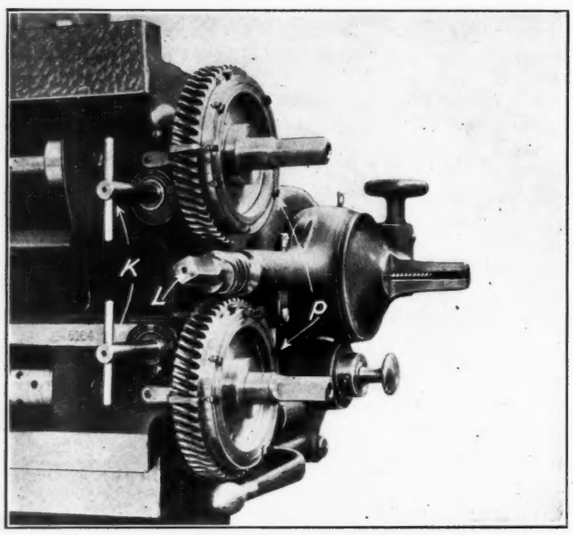


Fig. 3. Detail of Feed Gearing, showing Micrometer Dials and Observation Stops

the saddle. A safety device incorporated in each feed works, prevents the breakage of gears or mechanism through carelessness. Accurately graduated scales *N*, which facilitate setting the tools, are attached to the main turret slide and the cross-rail face. A scale is also attached to the tool-slide of the side head. Index dials with graduations indicating thousandths of an inch, are mounted on the feed-rods of both main and side heads. These dials are of large diameter, thus giving widely spaced graduations that are easily seen. Observation stops *P* (see Figs. 1 and 3) having numbers to correspond with those on the faces of the turrets, are adjustably mounted on the dials and are invaluable in the duplication of various sizes. As the rod and screw of the main head revolve rapidly when the power traverse mechanism is engaged, crank handles would be dangerous; therefore these have been supplanted by handwheels mounted on sleeves secured to the rod and screw. These wheels are free to make a partial revolution on the sleeves before becoming engaged with them. As the engagement imparts a hammer action similar to a hand tap on the end of a crank handle, a very fine adjustment is possible.

System of Lubrication

Special attention has been given to the lubrication of all working parts. The base of the machine forms an oil reservoir to which all oil is returned after passing through the various bearings and gear boxes. Submerged in this base and directly connected with the main driving shaft, is a gear pump which delivers the oil to a distributing reservoir *R*, Fig. 2, located on the outside of the column at such a height as to insure a free flow of oil through the ducts leading to the bearings and individual reservoirs in which the gears revolve. The excess oil pumped into this distributor is returned to the main reservoir by an overflow pipe. The ducts have oil sights that show the free flow of oil in two ways: First, by the size of the oil column passing through the opening if the pipe is clear, and second, by an overflow at the opening if the pipe becomes clogged. The construction of this oil sight is shown in Fig. 4. Fig. 5 indicates the construction of the table spindle and the method of lubricating this member as well as the table driving gear and pinion. Connection with the distributing reservoir is made near the lower end of the spindle, and the oil flows upward as indicated by the arrow, when the table is stationary, and is lifted from the base by spiral oil grooves *g* when the machine is in motion. Two wide channels *G* at opposite sides (located 90 degrees from the elevation shown) convey the oil to the driving mechanism. The primary and secondary speed change mechanism, clutch, brake and main driving shaft journals are also lubricated from reservoir *R* by a flow of oil which remains constant as long as the driving pulley is running. The feed-change brackets, power-traverse brackets and rail-raising

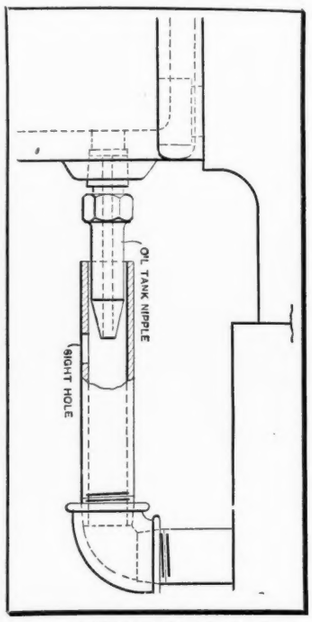


Fig. 4. Oil Sight for Distributing Ducts

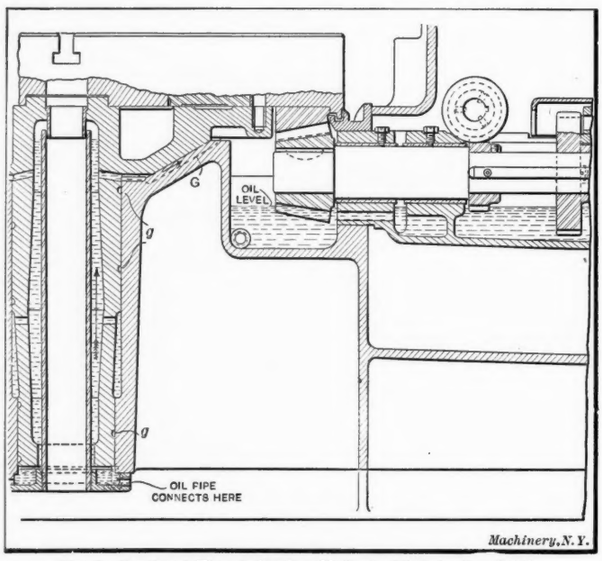


Fig. 5. Sectional View indicating Method of Lubricating Table Spindle and Driving Gears

bracket, which have a variable relation to the column, form a self-contained reservoir. The proper amount of lubricant is maintained at all points by oil level indicators. A complete equipment, including a pump, water-guard, pan and piping, for handling an ample supply of cutting lubricant can be furnished extra, if desired, and may be readily applied after installation.

Miscellaneous Features

The cross-rail has a wide face and a good bearing on the column to which it is secured by four bolts located at the ex-

treme points of the bearing. The side-rail has the form of an inverted letter L and is securely fastened to the column and bed. The guide bearing for the rails on the column and bed has great length in proportion to its width, thus insuring permanency of alignment in the vertical movement of these parts. The same type of guide bearing is provided on the cross-rail and side-rail for the saddles.

If the weight of a solid body of iron having a diameter and height equal to this machine's capacity were added to the weight of the table and spindle, the pressure on the angular thrust bearing of the table would be only 62.9 pounds per square inch, which is 12.1 pounds per square inch less than the maximum allowable pressure.

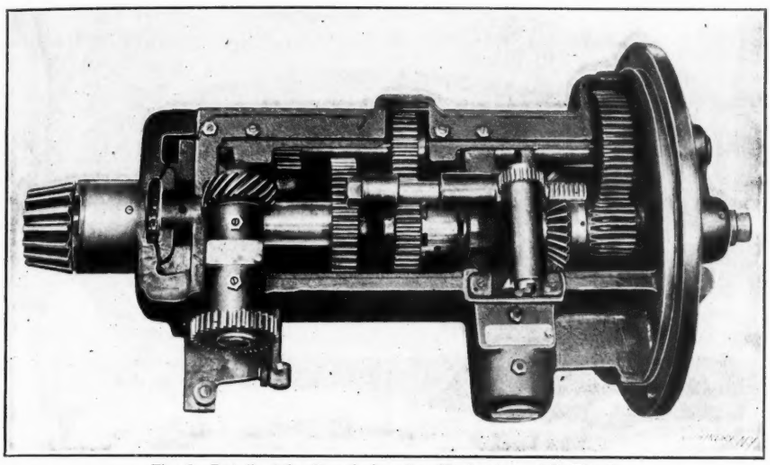


Fig. 6. Detail of the Speed-changing Mechanism at B, Fig. 2

Specially heat-treated alloy steel gears are used exclusively in the driving and feed trains of this machine, with the single exception of the table gear which is of such proportions that it cannot be successfully heat-treated. A special alloy, having exceptional wearing qualities in an unhardened state, is therefore used. All gearing is constantly immersed in oil and all high-speed journals are bronze-bushed and self-oiled. In the design of the machine, the safety of the operator has received careful attention. Counterweights and gearing are entirely encased, and crank-handles on rapidly moving power-operated parts have been eliminated.

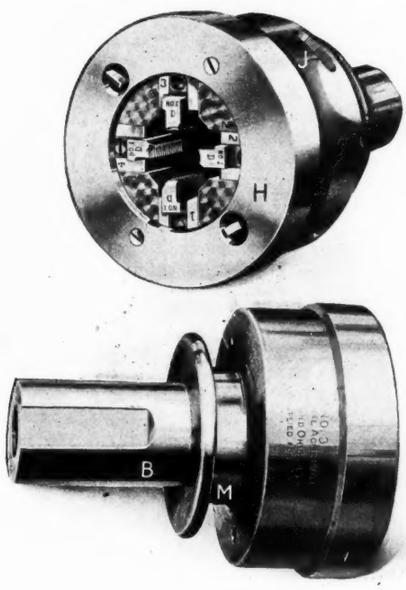


Fig. 1. National-Acme Opening Die for Screw Machines with Rotating Threading Spindles

A thread-cutting attachment for the vertical head, arranged for cutting eleven threads varying from two to sixteen per inch, can be furnished if desired. This mechanism is so arranged that the power rapid traverse may be used for returning the slide, and the thread-cutting feed again engaged without splitting the thread. When a motor drive is desired, a 10-horsepower constant-speed motor can be mounted on a bracket at the rear of the machine and connected with the driving pulley by a belt.

NATIONAL ACME OPENING DIE

The opening die illustrated in Fig. 1 has been developed by the National-Acme Mfg. Co., Cleveland, O., for use on the Acme automatic multiple-spindle screw machine or other machines using revolving threading devices. The distinctive feature of this die is that it can be operated while revolving and it has been designed particularly for screw machines in which the threading spindle rotates.

The working parts of the die are enclosed within a body *A* (see Fig. 2). The head *B* holds the chaser blocks *D*, which have closing and adjusting cams milled on their outer ends that bear against the cam-operating blocks *C*. The chasers *E* are held in place by the screws *F*, as shown, and they can be removed without displacing any of the other parts. A liberal adjustment for size is provided in the cam arrangement on the chaser blocks. This adjustment is controlled by a very fine pitch screw, and the amount is indicated by micrometer graduations *J*, Fig. 1. The blocks holding the chasers, and the cam surfaces controlling the closing of the die, are hardened and ground, and the wide bearings on the cam surfaces hold the jaws firmly in position when the die is closed.

The two positions of the die are illustrated in Fig. 2, the view to the left showing it closed and the one to the right in the open position. It is operated by a shoe engaging groove *M*, which shifts the outer shell and tapering finger cams *C* with relation to the chaser blocks, thus causing the latter to move inward or outward as the case may be. The chasers are so designed that they cut practically a perfect thread without the use of a follow-up cam. No springs are connected to the parts on which the adjustment of the dies or the operation of the closing cams depends. Chips are prevented from entering the head by the cap *H* and the die may be thoroughly cleansed by simply removing this cap and washing it in oil compound.

This new die has comparatively few parts and these are so arranged as to make it very easily taken apart and reassembled. This, however, seldom becomes necessary as the cap covering the head prevents the entrance of chips; the arrangement of the internal parts leaves plenty of room between them (excepting the faces of the cams and the surfaces they bear on) so that grit carried into the oil and other foreign substances can work into these clear spaces and out of the head through holes provided for this purpose in the sides. All parts of the die are made interchangeable so as to facilitate the reassembling or the replacement of worn and broken members. This company is prepared to furnish heads and chasers covering the entire range of screw machine requirements.

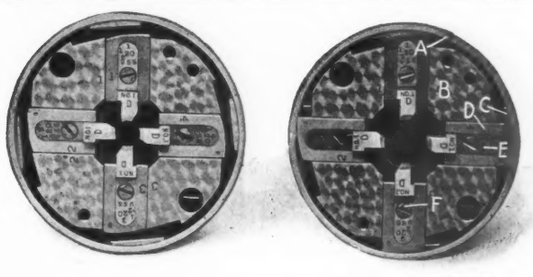


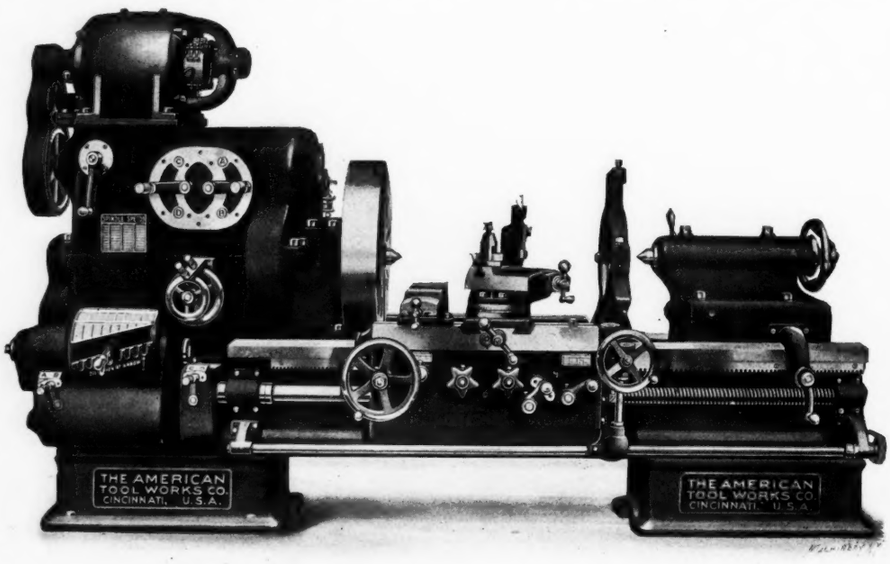
Fig. 2. National-Acme Die in the Closed and Open Positions

BEAMAN & SMITH TWO-SPINDLE ADJUSTABLE PORT-BORING MACHINE

The machine shown in the accompanying view was designed and constructed by the Beaman & Smith Co., Providence, R. I., for the purpose of boring the four valve ports in the cylinders of Corliss engines. Two ports are first bored simultaneously and then the cylinder is reversed for boring the remaining two. Holes from 3 inches to 9 inches in diameter and up to 6 feet in length, can be bored with the center-to-center distance varying from 8¾ inches to 37 inches.

To obtain accurate results when boring long holes, the boring-bars are revolved in one position and the work is fed (in either direction) past the cutters. The rigidity of this construction eliminates any inaccuracy due to the springing of the boring-bars. The feed mechanism can be reversed by the small lever seen at the right of the feed-box, so that the roughing cut can be taken in one direction, new tools inserted, and the finishing cut made as the table feeds back. The table has a quick-power traverse in either direction, which is operated independently of the spindle drive by a small motor at the rear of the bed. This quick traverse is controlled by the long lever seen below the spindle saddle, which operates friction clutches.

The spindles are driven by a 10-horsepower motor, which is geared directly to them with a reduction of 36 to 1. They run in taper bronze boxes and have an adjustment to compensate for wear. The adjustment of the driving mechanism for different center-to-center distances is provided for by transmitting the power from the large driving gear to a shaft located at right angles to the spindles. Each spindle head has a bracket attached to it and carries a bevel gear which slides on this shaft, and these gears transmit the power from the shaft to the spindle gears. This arrangement permits locating the spindles in different positions without interfering with the driving mechanism.

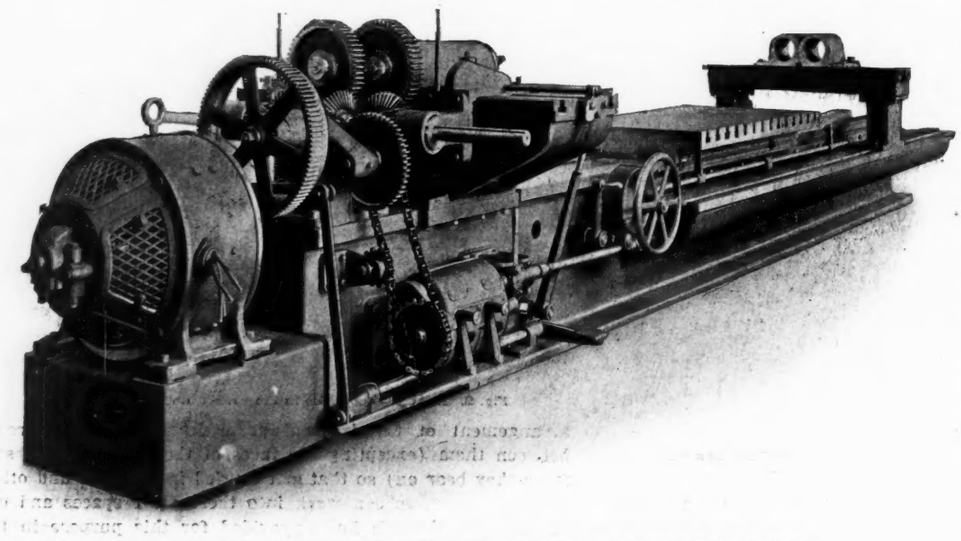


American High-duty Lathe with Motor Drive and Geared Head

The table has a working surface 36 inches wide by 6 feet long, and a travel of 13 feet 4 inches. It is operated by a screw of large diameter which engages a bronze nut. The thrust is taken by ball bearings and the mechanism is protected from dirt, chips, etc. The action of the table feed is made positive by gearing and a chain-driven feed-box. The feeding movement is transmitted from the gear-box to the feed-screw through a worm and worm-wheel which has an automatic trip on the table in either direction. A handwheel is provided for fine adjustment.

The boring-bars are fastened to the spindles by means of four bolts and a driving key for each spindle. The outer support for the bars is constructed in the form of a bridge, as shown, so that the table can pass under it. This support rests on projecting ways fastened to each side of the bed, and it has an adjustment of 14 feet along the line of travel.

A brake is provided on the large driving gear, operated by a foot lever on the side of the bed near the feed-box. The weight of this machine, without the motors, is approximately 24,000 pounds.



Machine built by the Beaman & Smith Co. for Boring the Ports of Corliss Engine Cylinders

AMERICAN HIGH-DUTY LATHES

In the March number of MACHINERY, we illustrated a high-duty lathe built by the American Tool Works Co., Cincinnati, O. This company is now manufacturing in 30- and 36-inch sizes the new design shown herewith. The particular lathe illustrated is motor-driven, but the arrangement is such that it can easily be changed for a single belt drive by removing the motor and replacing the larger gear with a suitable pulley. Inversely, a motor can easily be applied to a belt-driven machine at any time after installation by attaching it to a finished pad on the headstock (provided for that purpose) and connecting the armature and headstock shafts with three gears, as shown. A constant-speed motor either of the direct or alternating current type may be used.

By means of the geared head on this lathe, twelve fundamental spindle speeds are available, varying from 6 to 275

revolutions per minute. The speed changes are made by manipulating the levers and handwheel seen on the front of the headstock, and an index plate on the head shows plainly how to locate the levers for obtaining different feeds. The speed changing mechanism is very simple, there being fourteen gears for producing the twelve variations. The gears are cut from the solid, and are tested for accuracy on a special machine. The teeth of the slip gears are machine rounded to facilitate meshing. The motor is under constant control, as the controller handwheel is mounted on the right end of the carriage where there is a dial to indicate how the controller is set.

The quick change gear mechanism of this lathe has all-steel gears and gives a very wide range of changes for feeding and screw cutting. Forty-eight standard changes are shown on the index plate with threads varying from ½ to 28 per inch, including 11½ pipe threads, and feeds from 5 to 280 per inch. An index plate located on the feed-box, directly over the sliding tumbler, shows how to obtain each thread and feed. The feed-box is a complete unit having two levers and a steel sliding tumbler which works in conjunction with a cone of eight steel gears. All these gears are of the Brown & Sharpe, 20-degree, involute, pointed-tooth type, which facilitates meshing when running at high speeds and eliminates any tendency of the gears to "ride."

The bed of this lathe is of deep section and thoroughly braced by cross-box girths located at short intervals throughout its length, and it is further strengthened by a web cast longitudinally through the center, which carries a rack for engaging a pawl attached to the tailstock. This bed is the company's drop V-pattern which gives additional swing and permits the use of a comparatively deep carriage bridge. The carriage has a continuous bearing of 44 inches on the V's and it is gibbed its full length in the rear. The apron is of the double type, giving all shafts a double bearing. Both longitudinal and cross feeds are reversed by a lever at the front of the apron. All the gears and pinions are of steel and are cut from the solid. The rack and pinion can be withdrawn from the feed rack when screw cutting, and a non-interfering device makes it impossible to engage the feeding and screw-cutting mechanisms simultaneously. The tailstock is very heavy, as the illustration indicates, and it is moved along the bed by a crank and pinion.

This lathe is also built with a 3-step cone and double back-geared head, a 4-step cone and single back-geared head, and a 4-step cone with triple geared head. The double back-geared head provides nine spindle speeds; the single back-geared design, eight spindle speeds; and the triple-geared type, twelve spindle speeds. The gears of the latter are of the slip type and are readily engaged from the front of the head by manipulating a handwheel which also automatically engages the direct spindle drive when the faceplate pinion is withdrawn.

A double friction countershaft giving one forward and one reverse speed is regularly supplied with these lathes, except when motor-driven. If a reverse speed is not required, an additional forward speed will be available. The regular equipment includes compound, steady, follow, and full-swing rests, a thread dial, countershaft for belt drive, and wrenches.

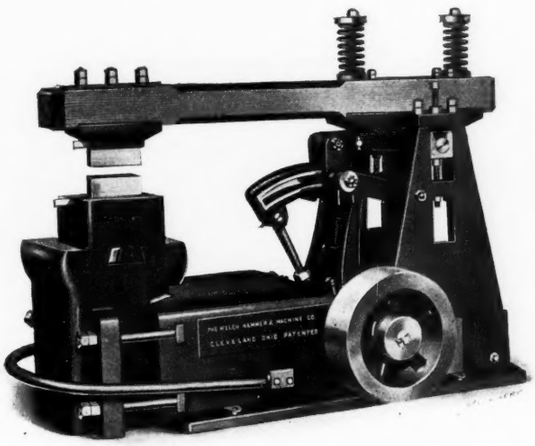


Fig. 1. Belt-driven Variable-blow Power Hammer, built by the Welch Hammer & Machine Co.

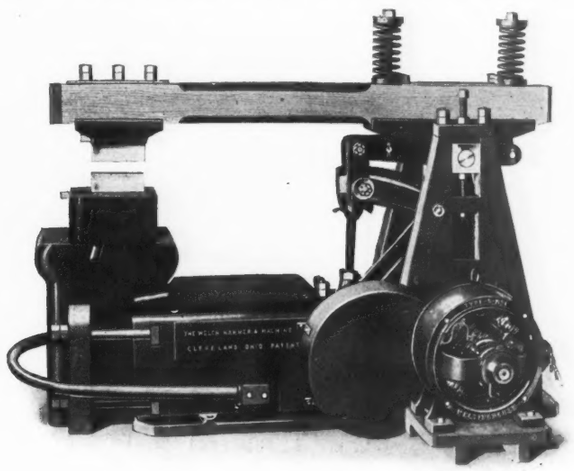


Fig. 2. Power Hammer with Direct-connected Motor Drive

VARIABLE-BLOW POWER HAMMER

A variable-blow power hammer recently put on the market by the Welch Hammer & Machine Co., 1523 Williamson Bldg., Cleveland, O., is illustrated in Figs. 1 and 2. The distinctive feature of this machine is the method of transmitting the motion of the eccentric which actuates the helve, to the latter through a link mechanism by means of which the throw of the helve and the blow is varied at the will of the operator.

A swinging bracket which supports and pivots one end of the link segment, is balanced on bronze bushings that also form the main bearings of the driving shaft. This bracket is connected by means of two short links to the treadle. A hardened bearing block, accurately fitted to the slot in the link segment, has end bearings in two U-links that are suspended from the beam lever. The short ends of these U-links are connected by means of straight links, to points in the housings directly in line with the pivot point of the link segment at full stroke. Fig. 1 illustrates a 60-pound hammer (arranged for belt drive) with the link segment on the dead center. The pivot pin of the link segment is in perfect alignment with the center of the sliding block segment, when on the dead center, so that as the free end of the segment is oscillated by the eccentric on the driving shaft, no motion is transmitted to the helve. The stroke or throw of the helve is therefore varied at the will of the operator from an absolutely dead position to the full stroke. The machine runs at a constant speed of about 300 revolutions per minute, and the advantage of being able to strike light finishing blows at high speed for a large class of work will be apparent.

Fig. 2 shows the machine with a direct-connected motor drive, and with the link segment shifted to the position of full stroke. The flywheel for a belt drive and the motor and gearing for a motor drive, can be applied to either side of the machine, and the motor drive is applicable to all sizes and styles. A balancing mechanism located between the housings balances the swinging bracket and removes all weight of the helve from the link. The helve is balanced on a pivot shaft and beam lever by means of the coil springs seen on top of the helve. These springs are adjustable and keep the helve under tension, with the result that it vibrates like a spring and strikes an exceedingly sharp and snappy blow.

The proportions of this machine are very generous. The anvil weighs 1500 pounds, or twenty-five times the weight of the hammer head, and the complete machine weighs about 5000 pounds. All the links and other small parts subject to strain or shock are steel castings or forgings. The helve is made of seasoned hickory. This machine will be made in all standard sizes and in other styles with guided heads to suit all classes of work.

BICKFORD AUTOMATIC FLUTING MACHINE

The Bickford Machine Co., Greenfield, Mass., has designed a new automatic machine for fluting four taps or reamers simultaneously. This machine is built in two sizes, the one shown herewith being for work up to ½ inch in diameter, while the larger size, which is back-geared, will handle work up to 1½ inch in diameter and is furnished with a fixture for squaring the shanks of taps.

The action of this machine is entirely automatic after the work is placed between the centers, the carriage making

Bickford Automatic Fluting Machine for Taps or Reamers

the forward and return movements and the centers indexing at the proper time for the different flutes. The carriage returns at a speed five times as fast as it advances, and is arranged to stop automatically, if for any reason the indexing should be improperly done, and also at the completion of the work.

The method of returning the carriage makes use of a gear-box containing three sets of compound gears, by means of which, together with a sliding clutch, it is possible to reverse the direction of the telescope transmission shaft and worm feed. The ratio of the gears for the return is 5 to 1, as before stated, and a special device is used which throws the sliding clutch forward to the reverse gear without knocking or pause while the change is being made.

The indexing of the centers is accomplished by a short spiral gear cut in each spindle, which meshes with a spirally-fluted cross-shaft, carrying at one end an index collar with the necessary stops, etc., for determining its motions. Power is applied to this cross-shaft by means of a second collar mounted on it and connected by ratchet teeth to the index collar as shown. As the carriage advances, this second collar is revolved, and by means of a pull-spring and the ratchet teeth, a tension is put on the index collar so that when the carriage returns, a special device unlocks the index; the cross-shaft is then revolved, turning the centers and work. The opposite end of this cross-shaft carries a disk which has a number of flat places milled on its circumference to correspond with the number of flutes required. These flat places are arranged to just clear a stud set in a bar which operates the feed, and a part of the disk that is not milled will depress this stud and throw out the feed; or if the indexing is not completed, a full part of the disk between the flat places will also stop the movement of the carriage. Another feature of the feed mechanism is a disk carried at the end of the main feed-shaft, on the circumference of which are stops to operate a small universal shaft which, in turn, shifts the clutch in the gear-box.

The cutters are supplied with oil from a tank in the base of the machine. A geared pump is used which is driven from the feed shaft. As the speed of this shaft varies according to the size of the work being done, a cone drive is provided which will allow the pump to be run at nearly constant speed. The centers in the tailblock are actuated by heavy coil springs and operated by a curved lever of special design in such a way that it is not necessary for the operator to place his hands near the rotating cutters. The weight of the No. 1 machine is 1100 pounds, and that of the No. 2 size, 1800 pounds.

GEARED FEED FOR ROCKFORD DRILLING MACHINE

The Rockford Drilling Machine Co., Rockford, Ill., is applying to its line of drill presses of the 26-inch size and larger, a new geared feeding mechanism giving eight carefully-selected changes. Fig. 1 shows a 26-inch machine of the sliding-head type equipped with this geared feed, and Fig. 2 illustrates its construction.

By referring to these two views it will be seen that the drive is taken from the horizontal shaft at the top of the

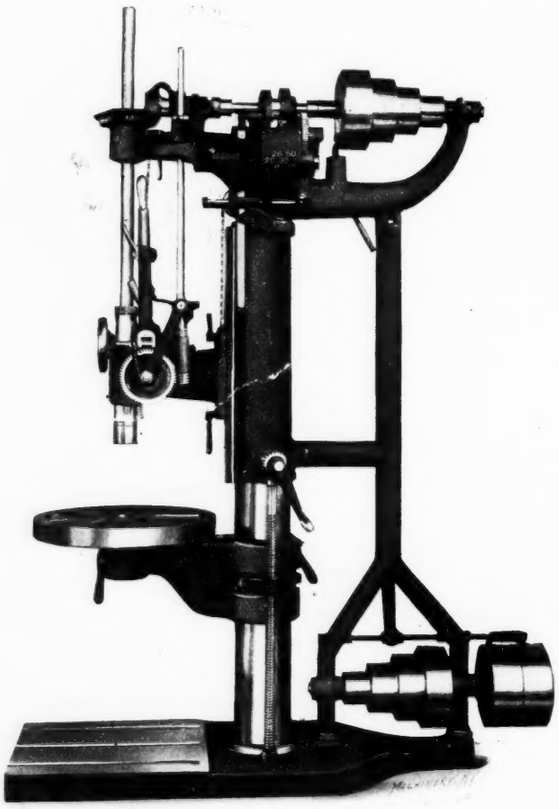


Fig. 1. Rockford 26-inch Drilling Machine with Geared Feed

machine. On this shaft there are two spur gears of different sizes which mesh with spur gears *A* (Fig. 2) on an intermediate shaft. The gears on the intermediate shaft are keyed and slide on a sleeve so that either of them may be brought into mesh with its mate on the top shaft, thereby giving two speed variations. The sleeve on which the sliding gears are mounted runs on a stationary shaft and has a pinion cut in

the end meshing with a tumbler gear *C* that can be engaged with any one of the four gears in the cone *D*. A hand-lever *E*, which is located at the side of the column and swings in a universal joint at its upper end, connects with an arm which carries the tumbler gear *C*. Lever *E* has a pin *e*, which, by engaging different notches cast solid with the frame, properly locates the tumbler gear for meshing with the various gears of the cone. This lever also passes through the shifter casting *G*, which has a forked end engaging the largest gear of the cone. When a change of feed is desired, lever *E* is lifted until the tumbler gear is disengaged from the cone; then by swinging the lever sidewise, the shifter casting slides the cone gears to the position required, after which the tumbler gear is dropped into its proper position.

As there are four gears in the cone, and two changes of speed are obtained through the sliding gears *A*, the total number of feed changes is eight. From the cone shaft, the feeding movement is transmitted through bevel gears to the vertical feed-rod. The guard or case which carries the cone gears is a part of the feed frame, and the various speeds are plainly marked on it in large figures as shown. A suitable pointer *p* is fastened to the shifter casting and extends close to the figures, thus showing the location of the gears and the resulting feed in thousandths per revolution of the spindle. The upper gears *A* are shifted by a lever *F* which extends down at the front of the machine. Letters *F* and *S* are placed above the two positions in which this shifter lever can be thrown, to indicate the fast and slow feeds and show the operator which of the sliding gears is in engagement. The feed can be entirely disengaged by placing this lever in a central or neutral position. The feed changes can be made when the machine is in motion.

The feeds obtained with this mechanism vary on the small machines from 0.006 up to 0.050 inch per revolution of the spindle, and on the larger sizes (28-inch and larger) from 0.006 to 0.083 inch per revolution of the spindle. The gears used in the construction are of ample width, and the bearings are long and well lubricated, thus making the mechanism strong and durable.

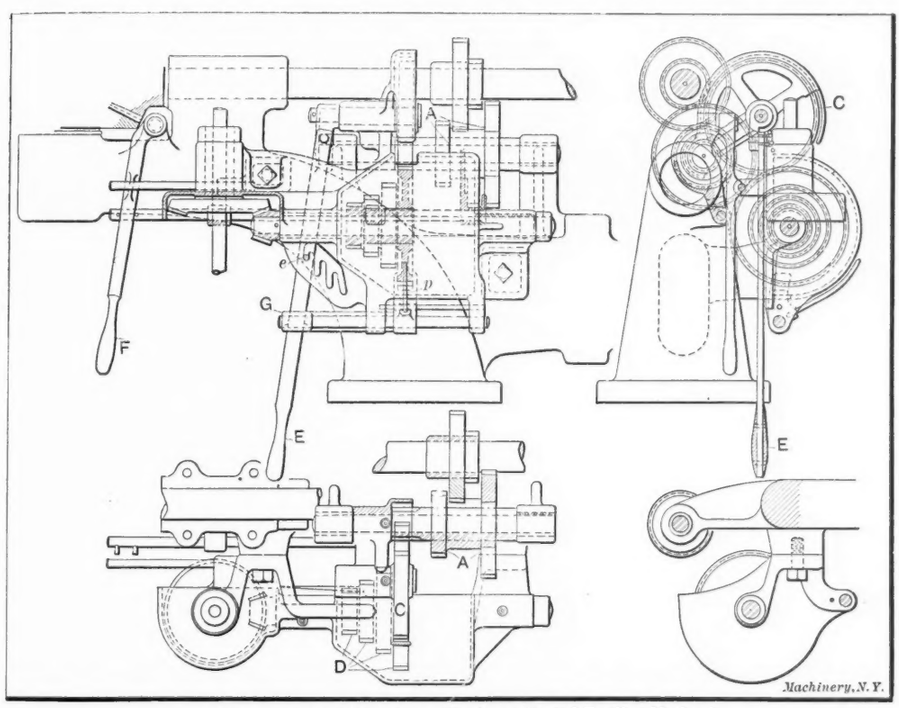


Fig. 2. Plan and Elevation of Rockford Geared Feeding Mechanism

READY TOOL CO.'S ROUGHING TOOL

Everyone familiar with modern machine tools is aware of the constructional changes that have been made since the introduction of high-speed steel, modern machines being much heavier and more powerful than those formerly built. These powerful machines, however, cannot produce efficient results unless proper tools are used in them, and very often up-to-date machines, such as lathes, for example, are equipped with turning tools which, as to shape and size, are not in keeping with the design of the machine.

The Ready Tool Co., Bridgeport, Conn., has brought out the heavy design of roughing tool illustrated herewith, to enable the maximum efficiency of a modern lathe to be obtained, as this tool is especially designed for high speeds and fast feeds. The inserted cutter used in this roughing tool is formed, both as to contour and cutting angles, according to the standards adopted by Mr. Fred W. Taylor as the result of his extended experiments in the cutting of metals. (A series of articles "On the Art of Cutting Metals," by Mr. Taylor, appeared in MACHINERY from January to August, 1907, inclusive.) As all the grinding is done on top of the cutter, the contour, as well as the side and front clearances, is automatically maintained throughout the life of the cutter, and the side and back slopes are ground to the correct angles by the use of a grinding templet furnished with each holder.

Heavy Lathe Roughing Tool, made by Ready Tool Co.

The cutter, as the illustration shows, has teeth on the rear side engaging with corresponding teeth cut in the clamping block, which is tightened by a set-screw on the side opposite that shown, and has a shoulder at the top which keeps it in position. With this arrangement, the cutter is firmly held and it can also be adjusted easily in an upward direction as the top is ground away. The tool is so designed that the resultant pressure from the work is carried downward through the cutter and dog to the base, making it very rigid and eliminating any tendency to chatter or upset. A tool of this type does away, of course, with all dressing and forging as the worn-out cutter is simply replaced by a new one. The cutter is made of the best quality of high-speed tool steel obtainable, and it is given expert heat treatment in hardening, thus making it unnecessary for the individual consumer to be equipped with high-speed furnaces, pyrometers, and other apparatus.

An idea of the size of this new tool (known as "Style R") may be obtained from the following figures giving dimensions for the four different sizes that are made: No. 1R, ½ by 1 by 6½ inches; No. 2R, ⅝ by 1¼ by 8⅛ inches; No. 3R, ¾ by 1½ by 9¾ inches; No. 5R, 1 by 2 by 12 inches.

From the foregoing description of this new roughing tool, it will be seen that the three factors essential to an efficient turning tool have been considered: The shape or contour of the cutting edge, the angles of clearance and slope, and the heat treatment.

TOLEDO SPOT WELDING MACHINES

Two designs of welding machines now being built by the Toledo Electric Welder Co., Langland and Knowlton Sts., Cincinnati, O., are shown in Figs. 1 and 2. The machine illustrated in Fig. 1 is operated by the foot-lever seen extending from the base. When this lever is pressed down, the dies are brought together to clamp the stock, and a slight pressure with the heel on the outside pedal turns on the current to complete the operation. When it is necessary to use both hands for placing the stock in the machine, this type of welder possesses many advantages over the hand-operated machine. Fig. 2 shows a design of welder that is especially adapted for stove and sheet-metal work, the extended horn making it possible to weld almost any part of a range without difficulty.

Metal sheets are joined by spot welding, as is well known, by electrically fusing or melting the metal at the point to be welded, and at the same time applying sufficient pressure to force the particles of molten metal together. The theory is that a poor conductor of electricity will offer so much resistance to the flow of the current that it will become heated, the degree of heat depending on the amount of current and the resistance offered. When making a spot weld, a large volume of

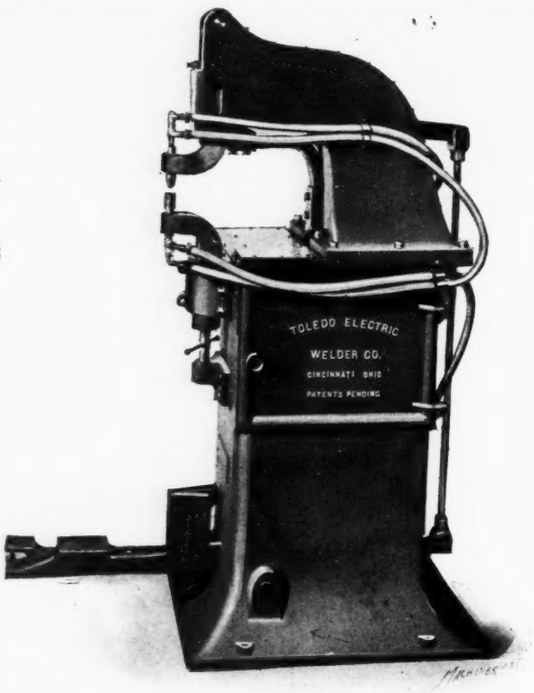


Fig. 1. Toledo Foot-operated Spot Welder

current at such low voltage that it cannot be felt with the bare hand, passes through a pair of copper die-points. The parts to be welded are placed between these points, and when the current is turned on, the pieces of steel offer so much resistance to its flow that they instantly become hot at a point opposite the copper dies. The hotter the steel becomes, the greater is the resistance and the current is forced automatically into the adjacent cooler parts until the temperature of all the metal in proximity to the dies is raised to the welding point. A slight pressure on the die-points then forces the molecules of molten metal together and they are perfectly united. This is done in an incredibly short time, only a fraction of a second being required for welding stock as light as 20 gage (0.0375 inch).

In operating the welder shown in Fig. 2, the stock is placed between the two copper die-points and clamped in position by pulling down on the lever, as shown. The switch is then closed by a thumb-latch on the lever and the weld is made in less time than one can tell about it, the electric current passing through the sheets and fusing the metal at a point or spot the size of a rivet. A special transformer is located in the base of the welder to reduce the voltage (220 or 440 preferred) down to that used for making a weld, which varies from 3 to 5 volts.

Several interesting examples of spot welding are shown in Figs. 3, 4 and 5. Fig. 3 shows a light piece welded to a heavier one, and also both sides of two sheet-metal pieces that have been spot welded. The pointed die leaves a slight indentation on one side, as shown, while the opposite surface is left smooth. Fig. 4 shows six pieces of sheet metal of varying thicknesses, which have been spot welded at one corner. The superiority

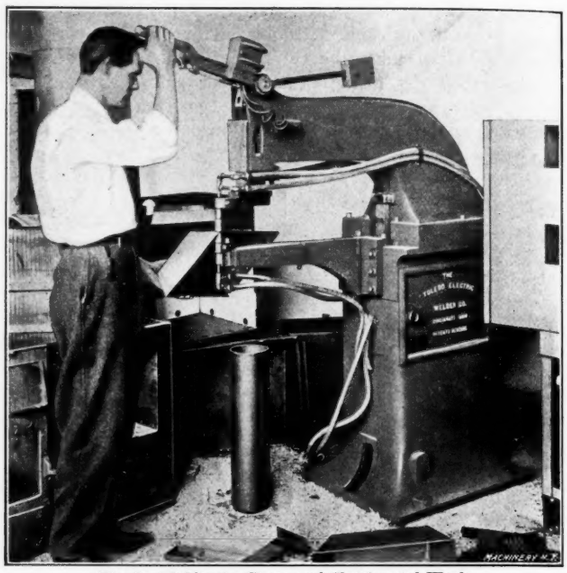


Fig. 2. Welder for Stove and Sheet-metal Work

of spot welding is indicated by the specimen shown to the right. An attempt was made to tear the pieces apart at the weld, which resulted in breaking out the metal around it, thus showing how perfectly the parts are fused together. Views showing both sides of a spot welded piece are shown in Fig. 5 to the left. In the center, sectional views of a spot welded and riveted joint are shown, which illustrates why a spot weld will stand 60 per cent more tensile stress than a riveted joint. In one case the two sheets are fused at the point where a slight depression is shown, and in the other, the metal is punched out for the rivet, thus weakening the sheet. To the right a

Fig. 3. Examples of Spot Welding

piece of galvanized iron is shown which has been hammered back in an attempt to break the weld apart.

A single-phase alternating current must be used for electric welding. If a two- or three-phase current is available, one

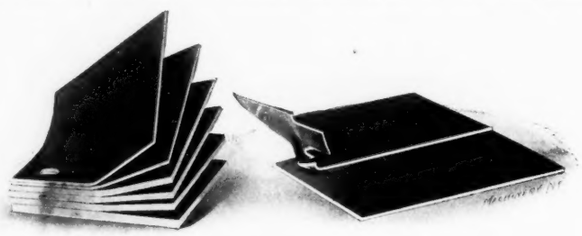


Fig. 4. Six Sheets joined by a Spot Weld—Test of Spot Weld

phase of the multi-phase system should be used. The voltage may vary from 110 to 500, but 220 or 440 volts is preferred. Any frequency from 25 to 140 cycles can be used. The expense for current based on the cost of 1 cent per kilowatt hour, will range from 1 cent to 3½ cents per 1000 welds. If the current costs from 3 to 5 cents, the cost per 1000 welds can be obtained by multiplying the price given in the accompanying table by the lighting company's rate.

No preparation of the stock is required for spot welding unless it is very rusty or scaly, in which case it will be found economical to clean off the rust or scale, as more current is used than on clean stock. Based on using fairly clean stock, the table referred to will give an idea as to the time and current required in welding different gages of sheet steel. There

TABLE GIVING TIME AND COST OF SPOT WELDING VARIOUS GAGES OF SHEET METAL

Gages of Sheet Steel	Thickness in Fractions of an inch	Thickness in Decimal Parts of an inch	Approx. K.W. Capacity	H. P. at Dynamo	Time in Seconds to weld	Cost per 1000 Welds at 1 cent per K.W.
10	9/64	0.140625	18	25	1.5	3½
12	7/64	0.109375	16	23	1.3	3
14	5/64	0.078125	14	20	1.0	2⅜
16	1/16	0.0625	12	18	0.9	2½
18	1/20	0.05	10	15	0.8	2¼
20	3/80	0.0375	9	14	0.7	2
22	1/32	0.03125	8	13	0.6	1⅞
24	1/40	0.025	7	11	0.5	1½
26	1/160	0.01875	6	9	0 4	1¼
28	1/64	0.015625	5	8	0.3	1

is a limit to the thickness of sheet metal that it is practical to spot weld. First, the copper rods which conduct the electric current can only carry a certain quantity of current without excessive heating. When sufficient current is carried over these copper rods or die-points to bring very heavy metal between them up to the welding temperature, the rods will become so hot they will soften and the points wear away so rapidly that it is not practical to use them for this kind of work. Second, it is necessary to have the two pieces of metal touch each other at the point where the weld is made. With very heavy stock, a slight kink or buckling of the metal will prevent the flat surfaces from making good contact. Stock as

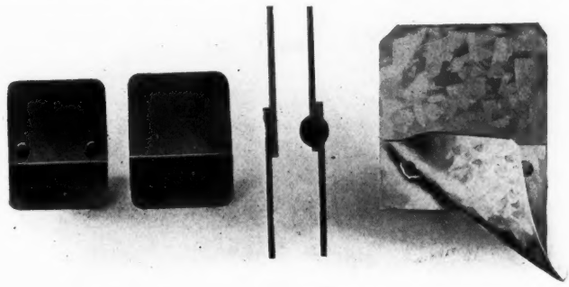


Fig. 5. Both Sides of Spot-welded Piece—Spot Weld and Rivet Joint—Test of Spot Weld on Galvanized Iron

heavy as 3/16 or 1/4 inch can be welded, but the best results are obtained with 1/8-inch or lighter stock.

Copper and brass cannot be spot welded for the reason that they are both good conductors of electricity and offer no resistance to the flow of the current. It is impracticable to weld cast iron, as there is no fiber to stock of this kind, and the metal will tear out at the welded spots. Galvanized iron can be welded, although the zinc will be burned off, leaving the iron exposed at the point where the copper dies come in contact with the metal. Heat has no effect on an electric weld and for this reason this process is largely used by stove manufacturers in making sheet-steel ranges and similar work.

It is not practical to make more than one spot weld at a time, as it is almost impossible to make a number of die-points bear on the stock with equal pressure, and the one die-point making the best contact will carry all of the current, which being concentrated at one point, tends to burn the metal.

To determine the tensile strength of spot welds as compared with riveting, ten specimens of hoop steel of the same size and measuring 1.12 by 0.035 inch, were subjected to tests at the Lunkenheimer Laboratory at Cincinnati, with the following results: Test 1 (see Fig. 6). Spot welded in one place—broke at weld with stress of 1625 pounds. Test 2. Spot welded in two places, also joined by two rivets—broke at rivets at 1555 pounds. Test 3. Spot welded in three places—broke outside weld at 2715 pounds. (Notice elongation of metal.) Test 4. Spot welded in three places, also three rivets—broke at rivets at 2055 pounds. Test 5. Solid lap weld—broke outside weld at 2720 pounds. Test 6. Butt welded—broke at weld at 2555 pounds. Test 7. Spot welded in one place and riveted once—broke at rivet at 990 pounds. Test 8. Solid lap weld—broke at weld at 2425 pounds. Test 9. Spot welded in two places—broke at weld at 2275 pounds. Test 10. Plain piece of hoop iron, not welded—pulled apart at 2690 pounds.

By comparing the tests made on the one and two spot welded joints with those having one and two rivets, it will be seen that in both cases the spot welds stood over 60 per cent more than the rivets. Comparison of the three spot welds with a three rivet joint, shows that the former test piece broke out-

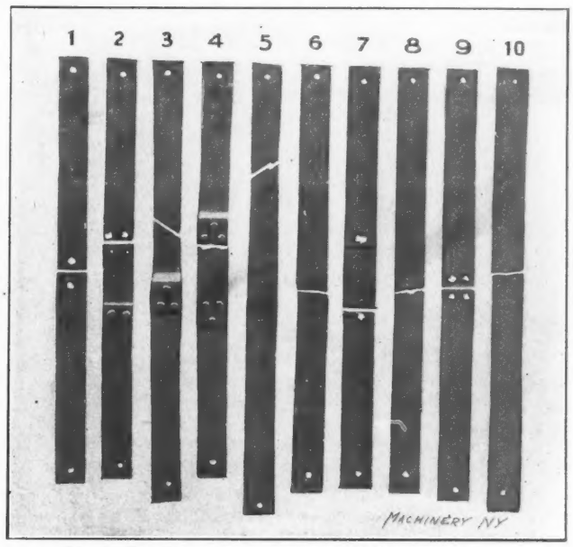


Fig. 6. Test Pieces joined by Spot Welding, Riveting, etc.

side of the weld with a pull of 2715 pounds, while the rivets tore apart with 2055 pounds.

These welding machines can be furnished for operation either by hand, foot or power, and they are made with throat depths varying from 6 to 48 inches and in a variety of styles to suit almost any kind of sheet-metal work.

LANG VERTICAL MILLING ATTACHMENT

A number of views of a vertical milling attachment now being manufactured by the G. R. Lang Co., Meadville, Pa., are shown herewith. This attachment is designed for the horizontal, knee-type milling machine and it differs from the ordinary vertical attachment in being offset with relation to the

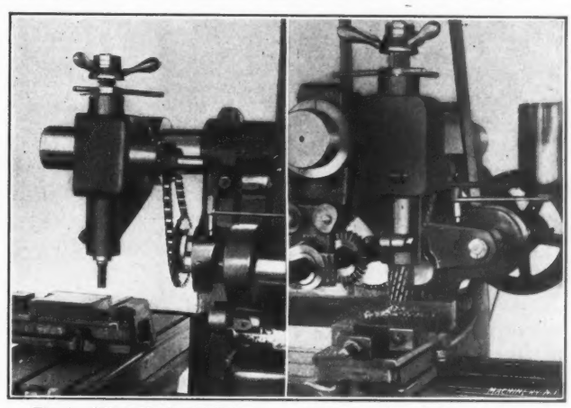


Fig. 1. Offset Vertical Milling Attachment

Fig. 2. Milling End and Side of Forging

main spindle, so that it can be used without interfering with the horizontal cutters. This arrangement makes the attachment applicable to such work as dovetailing and T-slotting, where the stock is first roughed out with a horizontal cutter and then followed up with an end-mill, as the cutters can be operated together and run in tandem.

The body of the attachment is clamped to the outboard bearing arm and the drive is by chain from the main spindle, as

shown in Fig. 1. This chain connects with a horizontal shaft that drives, through bevel gearing, the cutter spindle. The driving bevel gears are shown in Fig. 6, which is a front view with the protective cover removed.

This attachment can easily be placed on the machine or removed, it simply being necessary to loosen two clamping screws and unfasten a detachable link provided in the driving chain. The large driving sprocket is screwed on the spindle and it can easily be removed by a special wrench that fits holes in the side provided for that purpose.

Fig. 2 shows the application of the attachment for end-milling, and Figs. 3 and 4 illustrate its use for finishing the keyway in a shaft. A horizontal cutter is used first for roughing out the keyway, as in Fig. 3, and the vertical cutter in the attachment is then employed for end-milling the end of the keyway, as shown in Fig. 4. This operation is completed without changing the position of the milling machine table, as the attachment has 3 inches of vertical adjustment. This vertical adjustment is effected by a pilot wheel attached to the top of a threaded sleeve through which the spindle passes. By screwing this sleeve up or down, the vertical position of the spindle and cutter can be varied as desired. After the spindle is properly located, it is securely locked by the pilot nut shown just beneath the adjusting wheel.

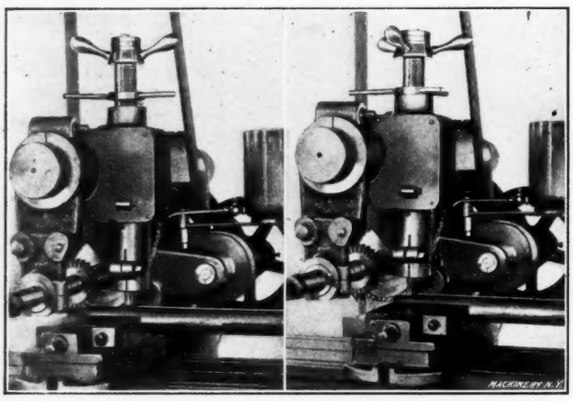


Fig. 3. Roughing out Keyway with Horizontal Cutter

Fig. 4. Finishing End of Keyway with Vertical Attachment

Another application of this attachment is illustrated in Fig. 5 which shows a vertical end-mill being used in the place of a regular horizontal cutter, where three cutters are used in a gang. Fig. 6 indicates the rigidity of the attachment. The part being milled is cast iron and a surface 2 inches wide is being finished by taking a cut ¼-inch deep with a feed of 3 inches per minute, which was the maximum capacity of the driving belts for the milling machine. The spindle of this attachment is hollow throughout its length, so that a drawbolt can be used for holding large cutters. These attachments are made for machines of all sizes.

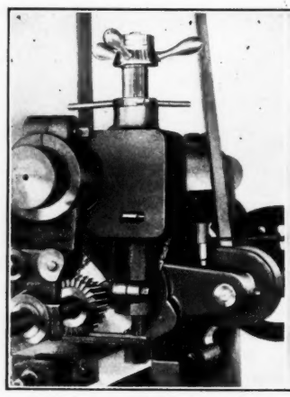


Fig. 5. Use of Attachment for Gang Milling

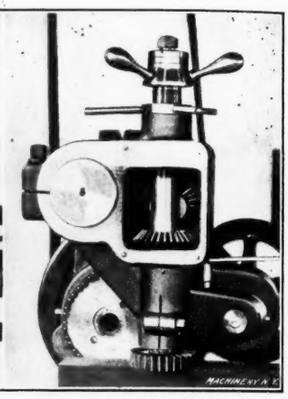


Fig. 6. A Surfacing Operation showing Attachment's Rigidity

VALLEY CITY GRINDING MACHINES AND BUFFERS

The Valley City Machine Works, Grand Rapids, Mich., has recently made several additions to its line of grinding machines and buffers. The illustration Fig. 1 shows a new grinding machine known as No. 24, which is larger and heavier than the grinding machines previously built by this company, though its constructional features are practically the same. The two-step cone pulley provided takes a 4½-inch belt, and the cone steps are 6 and 7 inches in diameter, respectively. The size of wheels recommended for this grinder are 24 inches in diameter by 4 inches wide. The bearings, which are 10 inches long and 2¼ inches in diameter, are self-oiling and protected by collars at the ends, making them dust-proof. The distance between the wheels is 33 inches and the floor space required is 23 by 33 inches. The weight of the machine without wheels is 725 pounds.

In Fig. 2 is shown a new buffer recently brought out, known as No. 22. This machine is heavier than the regular types built, and a heavy brace has been provided over the top, between the bearings to insure rigidity. The loose pulley is provided with self-oiling bushes; the bearing boxes are self-oiling and provided with collars at each end, so as to insure dust-proof bearings. The pulleys are 5 inches in diameter by 5 inches wide, and each of the bearings, 7 inches long by 1⅝ inch in diameter. The distance between the wheels is 39 inches; the size of the base of the machine, 22 by 17 inches, and the weight, 375 pounds.

Fig. 3 shows a combination disk grinder and buffer. On this machine the left-hand end is provided with an 18-inch disk and a tilting table the same as the company's regular No. 9 tool, disk and surface grinder. The right-hand end, however, has been remodeled, the ways for the knee have been removed, and a buffer head has been provided at this end. The interest-

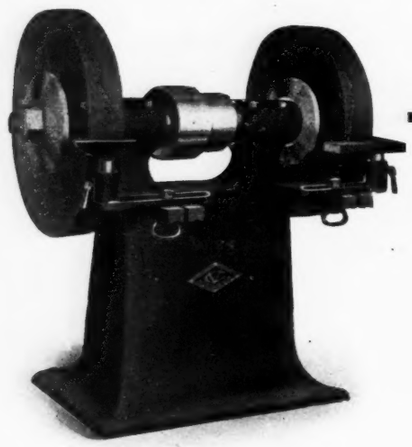


Fig. 1. Valley City No. 24 Grinder

Fig. 2. No. 22 Buffer

Fig. 3. No. 15 Disk Grinder and Buffer

ing feature of this buffer head is the efficient clamping device by means of which a strip of emery cloth can be securely held to the cylindrical surface and quickly changed, should a finer or coarser grade of cloth be desired. In the ordinary machine of this type the buffer head consists of a wooden pulley or disk having a leather rim attached to it, the emery being glued to the leather surface. On the machine shown in Fig. 3, the pulley is made of cast iron, and the clamping arrangement (shown in the line engraving, Fig. 4) is used for tightly binding the strip of emery cloth to the cylindrical surface of the buffer head. The gripping mechanism consists of two fingers *A* and *B*, between the ends of which the emery cloth is held. The cloth is laid around the rim of the pulley and then the ends of the strip are pulled into the slit *C* and clamped between the fingers by means of screw *D*. The cloth is then stretched by moving arm *B* in the direction of the arrow, and clamping it securely by the clamp-screw *E*. As arms *A* and *B* are pivoted at *F*, it is evident that the two ends of the emery cloth which are securely held between the ends of fingers *A* and *B*, will be pulled in and the strip of cloth stretched so as to come into close contact with the surface of the cast-iron rim.

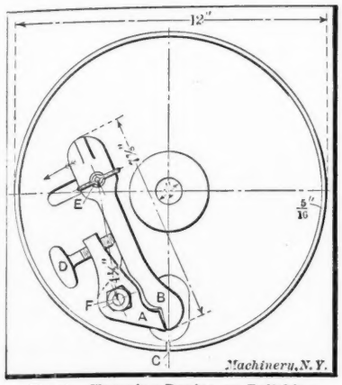


Fig. 4. Clamping Device on Polishing Head

Another improvement introduced on one of the company's machines is shown in Fig. 5; this is known as a reversible sliding table and is adapted to a No. 3 tool and surface grinder.

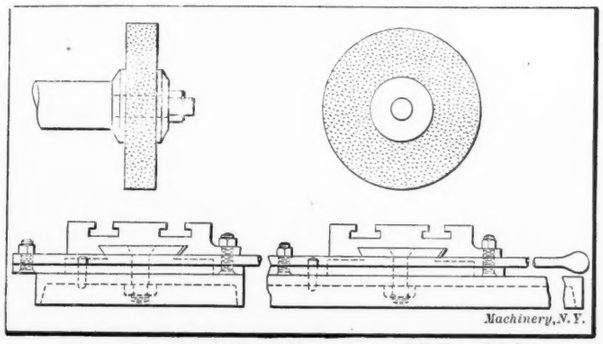


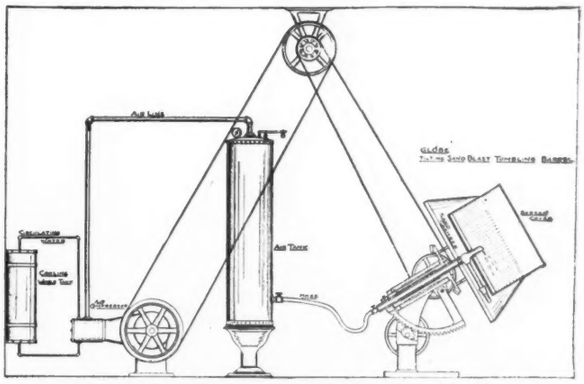
Fig. 5. Reversible Sliding Table for Tool and Surface Grinder

As indicated, this reversible sliding table is so arranged that it can be slid back and forth in either direction with relation to the wheel. It swivels on the main table on a bolt as shown. A taper pin and index holes in the main table are provided so that the reversible table can be set accurately in either position. The index holes, of course, are spaced 90 degrees apart. The table is moved back and forth by a lever pivoted at one end, and is fastened at its center to the table by a bolt.

GLOBE TILTING SAND BLAST TUMBLING BARREL

For cleaning rough castings, removing scale, burrs, and rust, or in the preparation of metals for machining, electroplating, galvanizing, tinning or japanning, the sand blast has proved economical and efficient. The tumbling of castings or metal parts in barrels is the most common method and has been used effectively for years, but where there are large quantities of work sand blast outfits are rapidly replacing the old method. In the tilting sand blast tumbling barrel, shown in the accompanying sketch (built by the Globe Machine & Stamping Co., Cleveland, O.), there have been combined the two methods of cleaning, namely, tumbling and sand blasting, and the result is a machine embodying the simplicity and cheapness of the tumbling barrel with the efficiency of the sand blast.

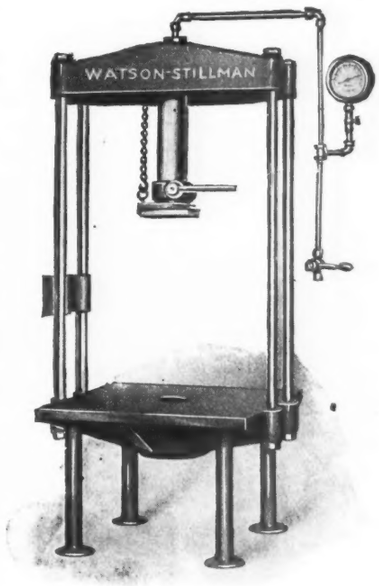
The operation of the outfit is as simple as that of an ordinary tumbling barrel. The contents can be watched closely while the barrel is in operation and the tilting feature allows the barrel to be readily emptied or adjusted to give more or less violent tumbling. The sand blast barrel requires no large sand reservoir or conveying machinery. The sand is drawn by suction from the sand chamber and discharged against


Tilting Sand Blast Tumbling Barrel built by Globe Machine & Stamping Co.

the work; it then drops through the perforations of the barrel into a sand chamber to be used over again. This barrel is not suitable for large castings, but for small work which can be readily tumbled. The outfit is inexpensive and has proved satisfactory in service. One man can easily operate from six to ten barrels.

WATSON-STILLMAN HYDRAULIC PRESS

The Watson-Stillman Co., 192 Fulton St., New York City, has added to its line another hydraulic press especially designed to conform to the demands of automobile work, which is also useful for general machine shop work. The weight shown on the left side counterbalances the ram which can be adjusted independently of the pump by means of a rack, pinion and lever arrangement. A hole through the platen permits the work to be projected or forced through. The capacity of the press reaches its maximum of 30 tons under a hydraulic pressure of 6250 pounds per square inch, which may be produced by using either a hand or belt-driven pump attached to the pipe shown in the engraving. The length of the ram stroke is 18 inches and its diameter is 3½ inches. Considering the capacity and size, the illustration gives the impression that this press is very light, but it is made strong by ribbed construction of the platens, and high grade material is used throughout. The press is raised to a convenient height from the floor by four legs.



Hydraulic Press designed for Automobile Work, etc.

HARRINGTON MULTIPLE DRILLING MACHINE

Edwin Harrington, Son & Co., Inc., Philadelphia, Pa., are making a multiple drilling machine that is especially adapted

for the rapid drilling of holes in flue sheets or similar work. This machine will drive three 1¼-inch high-speed drills in steel, and its noteworthy features are the ease with which the table and spindle heads are adjusted in and out, and the convenient arrangement of the operating handles.

The spindle heads are made of steel castings to keep down the weight and they have an independent in-and-out movement on the arms by hand-operated levers. The arms are traversed laterally along the cross-rail by a large hand-wheel operating through a rack and pinion. The table, as the illustration plainly shows, is mounted on rollers, thus giving an easy adjustment, and it is moved by a ratchet lever at the front, which operates pinions engaging with racks at both ends. There is a binder lock which holds the table securely in any position. If desired, a stationary table can be furnished, in which case it is rigidly bolted to the uprights and no base is used.

The spindles of this machine are forged of high carbon steel, have a large diameter in the sleeve, and are equipped with ball bearings for spindle thrust and also under the counterweight yoke. The counterbalance operates directly on the spindles and is constant in all positions. The feed, which is independent for each spindle, is operated entirely by gears and there are three changes. An automatic trip, by positive clutch on the feed worm shaft, and a wheel for hand feeding, are provided. The worm-wheel is disconnected for quick return of the spindle, by a positive toothed clutch on the handwheel.

The drive is by belt from an overhead countershaft, to a two-step cone-pulley connecting with a horizontal shaft which transmits the power through miter gears to a shaft on each arm and thence through miter and spur gears to the spindle. The two-step cone-pulley, in conjunction with the back-gears, gives four spindle speeds. When a motor drive is required, this can be arranged by belting a variable speed motor on the floor to a single pulley on the horizontal shaft. All mating gears in this machine are alternately of steel and bronze and have teeth of coarse pitch.

The cross-rail is of heavy box section, has a wide face for the arm saddles and a wide bearing on top of the uprights. The latter are very rigid and carry the runways and traverse racks for the table. The base by which the uprights are supported, is provided with a tank for the overflow oil, which is pumped to a long delivery tank under the cross-rail by an oil pump forming part of the equipment.

Some of the principal dimensions of this machine are as follows: Surface of the table, 7 feet 2 inches by 3 feet 4 inches; minimum distance between the spindles, 18 inches; maximum distance between end spindles, 8 feet; in-and-out movement of the spindles, 6 inches; vertical traverse of the spindles, 15 inches; maximum and minimum distances from spindles to table, 27 and 12 inches, respectively; in-and-out movement of the table, 3 feet 4 inches; clear opening between uprights, 9 feet 2 inches; range of spindle speeds, from 50 to 150 revolutions per minute; range of feeds per revolution, from 0.0036 to 0.0108 inch; and weight, 18,800 pounds.

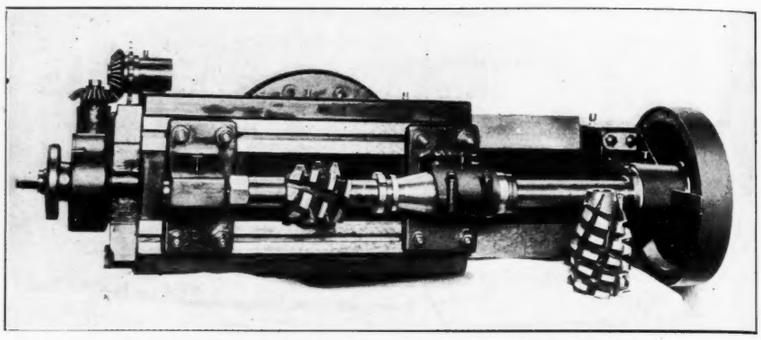
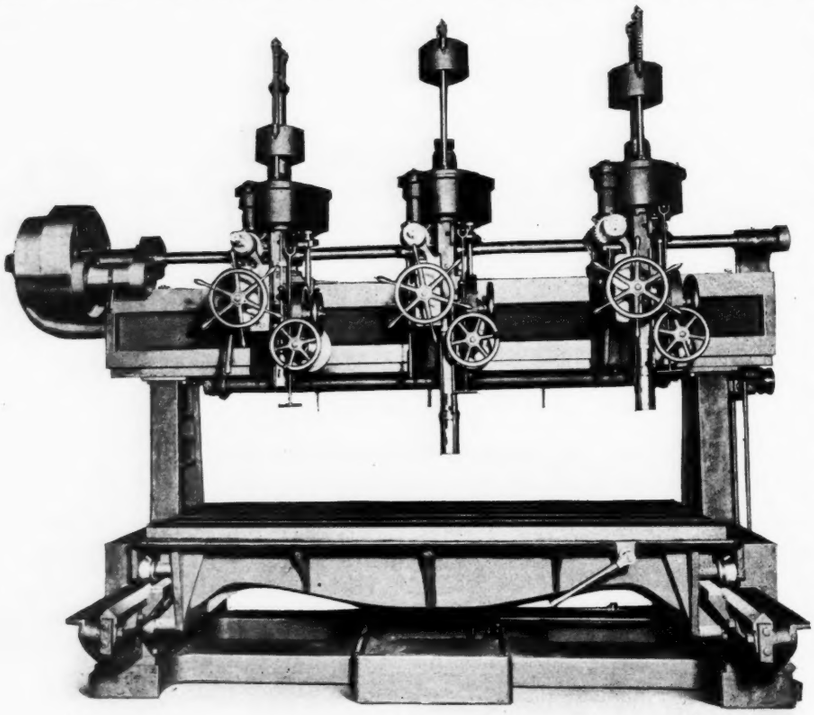


Fig. 1. Worm-wheel Hobbing Attachment for Gear-hobbing Machine



No. 14 Multiple Drilling Machine, built by Edwin Harrington, Son & Co.

WORM-WHEEL HOBBING ATTACHMENT

As is well known, there are a number of different methods employed for cutting the teeth in worm-wheels. A very common way is to first gash the blank and then use a hob for finishing the teeth. This process only requires an ordinary milling machine, and it is the one followed in most shops for making worm gearing of small size. Another method sometimes used is to gear the hob and work positively together so that previous gashing is not required. This method is quicker than the one first mentioned, but requires a special machine or attachment. A third method which produces the most accurate teeth, and which is the least expensive as regards cutting tools, is what is called the "fly-cutter" method. This method requires a special machine or attachment, but is the best one to use when accurate and silent-running gearing is required.

There are two reasons why a higher degree of accuracy is obtainable by using a fly-cutter: In the first place, it produces the teeth by a generating action, and secondly, it can be ground accurately to size after hardening, thus eliminating the inaccuracy frequently found in a hob which has distorted in hardening. When many gears are to be cut, the bar with a fly-cutter is frequently replaced by a taper hob which is gradually fed tangentially by the work from one end, thus completing the teeth as it is fed past the center of the worm-wheel. This method is also an accurate one because the full size teeth at the back end of the hob are not in action until the final finishing of the worm-wheel, so that their shape is preserved much longer than is possible in an ordinary hob. Another advantageous feature incident to both the taper hob and fly-cutter methods is that the distance between the center of the work arbor and the cutter spindle is fixed at exactly

the distance between the axes of the worm and worm-wheel, there being no feeding in of the fly-cutter or taper hob towards the gear, but merely a feeding of the cutting tool tangentially by the gear.

An attachment for cutting worm-gears either by a fly-cutter or a taper hob, has recently been placed on the market by Schuchardt & Schutte, Cedar & West Sts., New York City. This attachment, shown in Fig. 1, is used on the regular gear-hobbing machine sold by this firm, this machine, without the attachment and provided with the regular cutter head, being used for hobbing spur and spiral gears. It consists of a duplicate head which is provided with a cross-feed. When it is desired to use a fly-cutter or a tapered hob for generating a worm-gear, the regular cutter-head is taken off the machine and the head with cross-feed is substituted. Power is given to the cutter arbor through the same train of gears that drives the hob mandrel of the regular head. The same chain that furnishes the vertical feed motion to the regular cutter-head

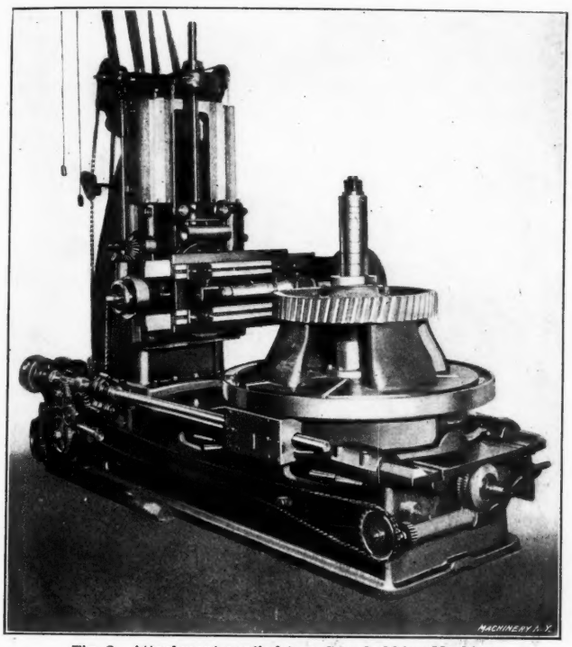


Fig. 2. Attachment applied to a Gear-hobbing Machine

controls the cross-feed on this special head. All that is required is to lengthen the chain and permit it to pass over two idlers, as can be seen on the left-hand side of the machine. This furnishes a direct cross-feed motion to the hob mandrel

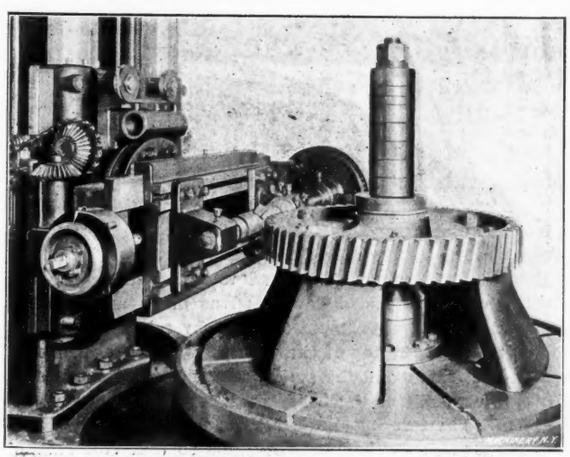


Fig. 3. Worm-wheel Hobbing Attachment equipped with Fly-cutter

or cutter-bar. The amount of this feed may be reduced or increased, of course, to suit the characteristics of the material of the gear blank.

The differential gearing that is used when cutting spiral gears to compensate for the angle of spiral while feeding the hob down past the work, gives the required compensation for the motion of the taper hob or fly-cutter as it feeds past the worm-wheel; thus no complications are introduced in this machine as regards the gearing, the gearing of the regular machine meeting all the requirements. The differential gearing, by means of which the compensating movement is effected, is of the Pfauter patent and was described in the April, 1908, number of MACHINERY, in one of a series of article on gear-

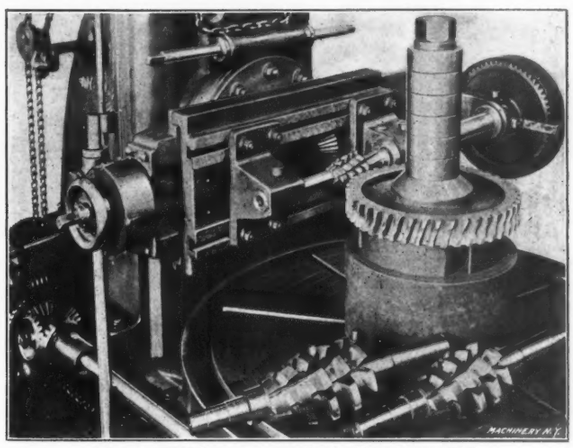


Fig. 4. Hobbing a Worm-wheel with a Taper Hob

cutting machinery, which extended from January to August, 1908, inclusive. The method of cutting worm-wheels by generating was treated in detail in the June, 1908, number of MACHINERY, engineering edition.

The addition of this attachment to the Schuchardt & Schutte machine furnishes a simple and accurate means for producing worm-wheels that will run in perfect mesh with the worm. A worm-wheel hobbed with a straight hob is satisfactory only when the angle of the hob thread is very slight, as in a single-thread hob of large diameter. When the angle of the thread increases, the straight hob leaves ridges on the sides of the teeth at the bottom, and the worm bears on spots when in service—at least until the ridges have worn down. The cost of a hob is, of course, also very much greater than that of a fly-cutter—the cost frequently being ten times as much—and for this reason the fly-cutter method of producing worm-gears, is practically the only one permissible when only a few large worm-gears are to be cut. As already mentioned, for a large number, the taper hob method is preferable.

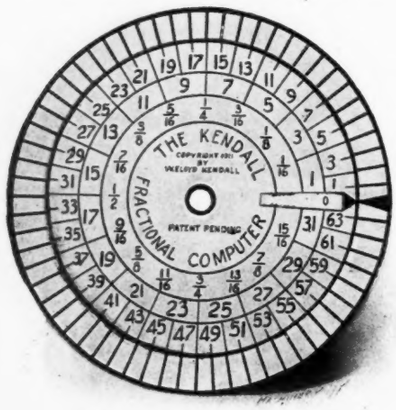
A machine with this equipment has recently been installed at the works of the A. B. See Electric Elevator Co., Jersey City.

KENDALL COMPUTER FOR ADDITION AND SUBTRACTION OF FRACTIONS.

The Kendall fractional computer is a device designed to facilitate the addition or subtraction of fractions, so that this part of mathematical work can be done in a minimum of time. It is very simple, and consists of two cardboard disks joined by a brass eyelet. The lower and larger disk has sixty-four equally spaced lines representing 64ths of an inch, and the upper disk has three sets of graduations as shown. The outer circle of figures represents the numerators of 64ths, the next circle 32nds, and the inner circle has the fractions fully expressed. The upper disk is free to revolve and contains a slot through which the fractions and their decimal equivalents on the lower disk can be seen.

When computing with this device, the slot is placed first over the zero mark on the lower disk, as shown. If two fractions are to be added, that line on the lower or "result" disk that is opposite one of these fractions on the upper or index disk is noted, and the slot of the index disk is moved opposite that line. The line on the lower disk opposite the fraction to be added is then noted and the slot is again moved opposite this second line; the sum of the two fractions will then show through the opening. For example, to add 7/64 to

9/32, the slot of the index disk must first be moved opposite the line on the lower disk that coincides with the figure 7 of the 64ths circle. The position of the 9 in the 32nds circle is then noted, and the slot turned to that position, as shown by the coinciding mark on the lower disk. While these changes of the index disk are being made, the points on the lower disk to which it must be turned can easily be marked with the finger. By proceeding in this way, any number of fractions can be added, but care should be taken to add 1 to the result each time the slot in the index disk passes the zero mark or makes one complete revolution.

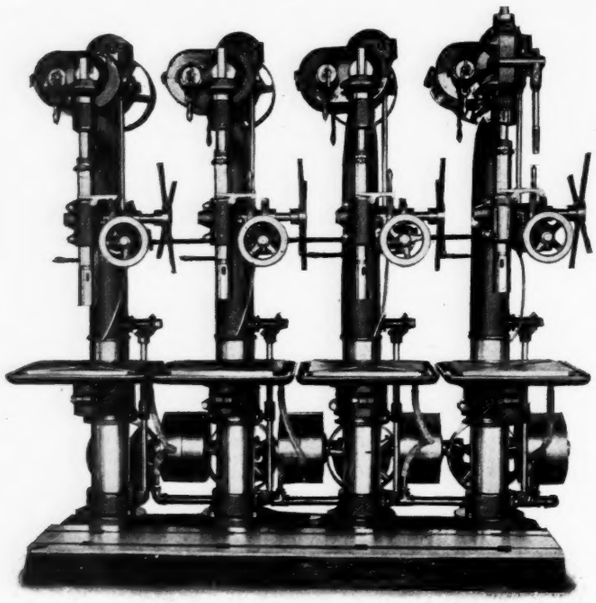


Kendall Fractional Computer

When subtracting, that line on the lower disk opposite the fraction to be subtracted from, is placed opposite the fraction to be subtracted; the difference is then read through the opening. This device should prove of special value to draftsmen and others frequently engaged in mathematical work. It has been placed on the market by W. Floyd Kendall, West Haverstraw, N. Y.

SIBLEY FOUR-SPINDLE DRILLING MACHINE

A four-spindle high-speed drilling machine now being built by the Sibley Machine Tool Co., No. 8 Tutt St., South Bend, Ind., is illustrated herewith. This machine has four individual square tables, as the engraving shows, that are located close together so that they can either be used as one table for the whole machine or any one of them can be raised



Sibley Four-spindle High-speed Drilling Machine

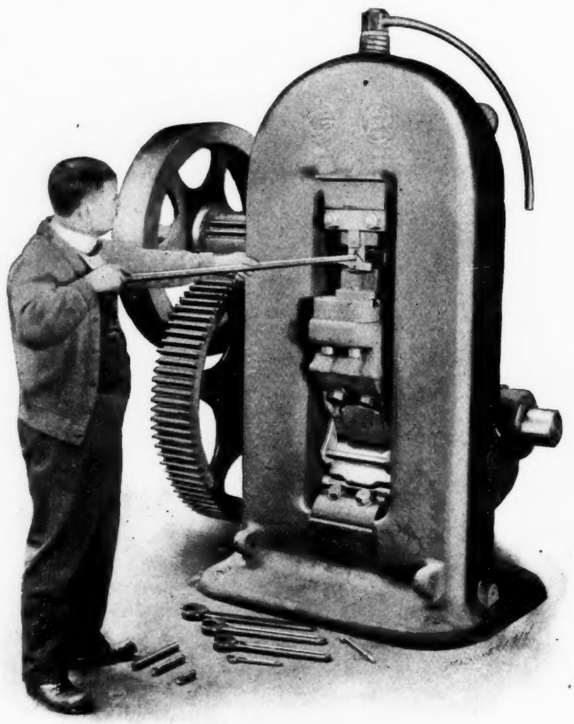
or lowered to accommodate different sized jigs. Each spindle is also independent from the others in operation and has a separate quarter-turn countershaft, instead of a single-pulley drive for all four spindles with connection through friction clutches for each machine. This method of driving was selected as the best for delivering the full amount of power to each machine, and it also eliminates all troubles that may arise from the use of friction clutches. Lubricant is supplied to all four spindles from a large tank by a geared pump driven from one of the countershafts. After being used, the lubricant returns to the tank through drains in each table.

The general construction of this machine is similar to the company's standard high-speed types. The operator can take care of all four spindles without being obliged to go back of the machine or even to the side for any speed changes or adjustments of any kind; the machine can be started and stopped, speed and feed changes made and the spindle returned, from the front. The usual geared tapping attachment is fitted to the fourth spindle. This type of machine is built in two- and three-spindle styles also.

FERRACUTE PRESS FOR HEADING STAY-BOLTS

The Ferracute Machine Co., Bridgeton, N. J., is now building a press fitted with dies by means of which a square head is formed on a boiler stay-bolt blank at one stroke of the machine. If desired, the press can be modified to form the head and cut the blank from the bar at the same stroke.

The accompanying illustration shows one of these machines. The design is very compact, the frame being a solid casting



Ferracute Press for Heading and Cutting-off Stay-bolts

with only 14 inches between the columns, thereby reducing to a minimum any spring in the frame when the press is in action. The stroke of the press is 2 inches, the ram being forced upward by steel toggles that are actuated by a 6-inch steel shaft in the rear. The head to which the upper die is attached can be adjusted downward as much as ½ inch, by means of a wedge adjustment operated by a bolt and lock-nut. The bolt seen at the top of the press keeps the head firmly up against the frame, and the spring shown has sufficient tension to take the weight of the head when operating the wedge adjustment. The forming dies are V-shaped, and there is an adjustable gage at the back of the press so that bolt blanks of various lengths may be cut off.

The flywheel on this machine weighs 1100 pounds, is 40 inches in diameter, and runs 180 revolutions per minute, producing at that speed 30 strokes per minute. The total weight of the press is over 16,000 pounds and it gives a pressure of 400 tons. The illustration shows the operator in the act of making ⅞-inch stay-bolt blanks from a steel bar of that

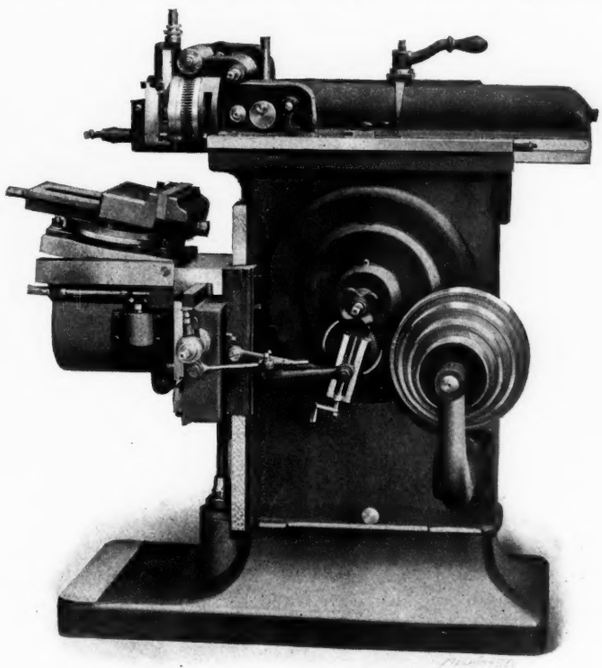
diameter. This press is supposed to run continuously. The company for whom it was built formerly headed their bolt blanks in a slotter, producing about one per minute, the blanks having been previously cut off from the bar by another operation. Inasmuch as the Ferracute machine performs both operations at the rate of 30 per minute, a fair idea of the saving effected may be obtained.

STOCKBRIDGE UNIVERSAL SHAPER

The Stockbridge Machine Co., Worcester, Mass., has recently brought out a 16-inch single-geared shaper equipped with special attachments that make it possible to meet practically every requirement in the way of shaper work found in the tool-room or in connection with die-making. The special features of this new design are: the power rotary feed; automatic feed for the head-slide either up or down; automatic stop for the down feed; and swiveling or rotary knee.

The power rotary feed for the head, or the concave attachment, is mounted on the top of the ram and the head is revolved by a worm and worm-gear. The worm is connected by a train of gears to the pawl seen on the side of the ram, and this pawl is reciprocated by a dog which is adjustable along the ram gib. By adjusting this dog, the throw of the pawl can be varied and consequently the feeding movement to the head. The worm can be turned in either direction, and the construction is such that the head can be rotated by hand when desired. The head can be locked to the ram, when not in use, by means of two bolts located on each side.

The automatic stop for the down feed of the head-slide will be found of advantage in producing duplicate parts. It prevents the tool from feeding down too far and spoiling the work, and also allows the operator to attend to other work while the machine is running. The amount of automatic feed for the head-slide is regulated by the position of the dog on the



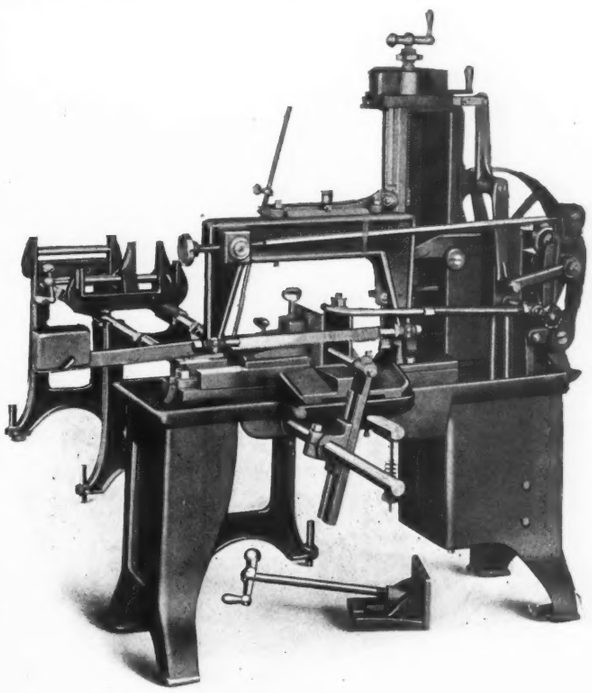
Stockbridge Universal Shaper for Tool-room and Die Work

ram gib. A micrometer graduated to thousandths of an inch is provided on the feed-screw and can always be set to the zero position.

The swiveling or rotary knee has two working sides and is revolved by a worm and worm-gear through an arc of 90 degrees in either direction. One side is made to tilt for planing angles, which is especially useful in die-making. All the feeds and adjustments on this machine are within easy reach of the operator. The Stockbridge patented two-piece crank is used, giving a quick return of 3.5 to 1 (which is maintained for short strokes) and an even cutting speed throughout the length of the stroke. The shaper has a maximum stroke of 16½ inches; the vertical travel of the knee is 16 inches, and the horizontal travel is 20½ inches. The ram has a 26-inch bearing in the column, and the machine weighs 2000 pounds.

"MARVEL" HIGH-SPEED AUTOMATIC HACKSAW

The Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill., has added to its line of hacksaw machines a size known as the "No. 5," which is entirely automatic in its operation. After a piece is cut off, the bar is fed forward and a new cut started, all automatically and without stopping, this operation being continued until the bar is cut up.



Armstrong-Blum No. 5 High-speed Hacksaw with Automatic Stock Feed

The stock is clamped in a vise which travels along the double track at the rear of the machine. When a piece is cut off, the saw rises and at the same time the vise opens. When the saw is up out of the way, the stock-feeding attachment draws the traveling vise and the bar forward until the end of the bar is stopped by the adjustable gage shown; the saw then starts down, the vise closing at the same time, and a new cut starts. The time required for this cycle of operations varies from ten to fifteen seconds.

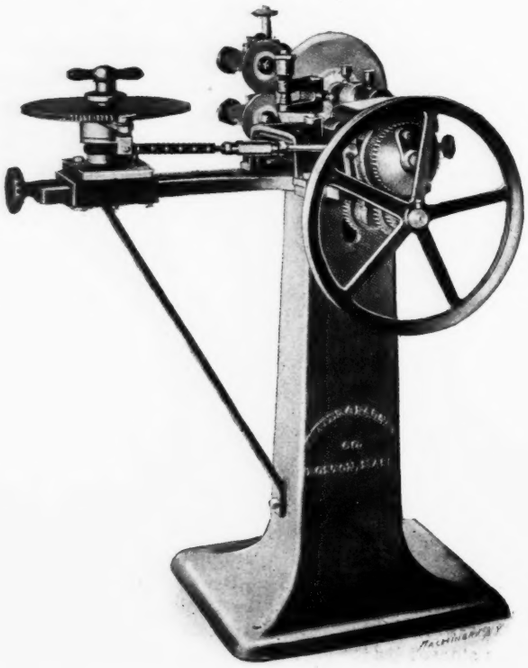
The saw frame always moves horizontally, and it is actuated by a crank-lever which imparts a smooth, even cutting stroke to the blade and gives a quick return. The entire blade can be used by shifting the saw frame by means of a right- and left-hand screw on the connecting-rod; this adjustment can be made with the machine in operation. The stroke of the saw can be changed from 4 to 6½ inches by means of a shifting bolt in the crank. The chuck or vise has liberal dimensions, the jaws extending out flush with the saw-blade. This vise will take stock up to 8 inches, and it can be shifted forward or back or swiveled either to right or left for cutting to an angle. In a slot in the saddle back of the machine there are two dogs, the upper one of which may be set to stop the cut at any desired depth. Any pressure on the saw-blade can be obtained by means of a friction disk at the top of the screw. The saw cuts on the draw stroke and lifts free of the work on the return.

This machine is provided with an overflow tank and a reliable plunger pump which gives a steady stream of compound on the saw-blade. This pump, which is immersed in the bottom of the tank, can be removed with all its connections by simply removing two cap screws. An idea of this machine's

cutting speed may be obtained from the following examples representing the performance of an ordinary hacksaw blade: Time for cutting 1-inch round steel, ¾ minute; 2-inch steel, 2 1/3 minutes; 3-inch, 5 minutes; 4-inch, 7¾ minutes; 5-inch, 13 minutes; and 6-inch, 24 minutes. Duplicate pieces are cut to the same length in this machine, and the automatic feature effects a considerable saving of time and labor. It is furnished, if desired, without the stock-feeding attachment.

NUTTER & BARNES AUTOMATIC SAW SHARPENER

The Nutter & Barnes Co., Boston, Mass., has brought out an automatic saw sharpener that is adapted to the forming of Brown & Sharpe patent, relieved teeth for cutting soft metals, or for plain saw gumming. The special feature of this machine is that it will sharpen, back-off, and form a relieved tooth at one setting, and in the same time as required for plain gumming. The four different operations necessary to form one relieved tooth are performed by means of cams and gears at each advance of the main gumming-wheel, and from 40 to 50 saw teeth can be formed per minute, the number depending on the diameter of the saw.



Nutter & Barnes Automatic Saw Sharpener

The saw is indexed by a disk, 12 inches in diameter, having the same number of teeth as the saw being sharpened. The function of the gumming-wheel is to gum, sharpen the face, back-off, and regulate the two lengths of saw teeth, the narrow alternating teeth being 1/64 inch longer than the full width teeth. The two 4-inch narrow grinding wheels shown, bevel and form the clearance of the alternating bevel teeth on the beveled part. As the wheels are gradually withdrawn and the saw starts to revolve, the proper clearance is given to the bevel. In the same way, the full-width as well as narrow teeth, receive their regular backing off from the corner of the beveled wheel; that is, while the teeth are revolving past it.

The different numbers of teeth in saws, and the variations required in backing them off, are obtained from an adjustable feed cam in which holes are located in the proper position to receive an index pin carried in an arm on the cam shaft, each hole being marked for the different numbers of teeth in saws of various diameters. This machine will also sharpen the face and form the gullet of a plain straight saw-tooth, and in this case the indexing is also regulated by a plate having the same number of teeth as the saw being sharpened. These machines are built in two sizes—for saws ranging from 12 to 20 inches in diameter and from 12 to 36 inches, respectively.

LANG TOOL-HOLDER

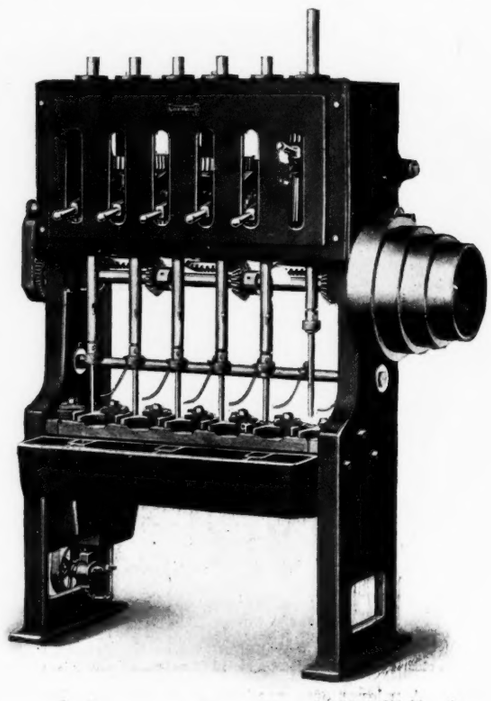
The G. R. Lang Co., Meadville, Pa., is now manufacturing a new form of tool-holder which differs from the maker's regular holder in that the cutter is set at an angle so that the cutting edge projects beyond the side of the holder proper. This allows the tool to be used in a corner and for facing a shoulder, without the necessity of swinging it around to an angle with the work. This feature especially adapts this style of holder to

Tool-holder made by G. R. Lang Co.

vertical boring mills and turret lathes equipped with toolposts that can only be swung to a fixed position. The triangular form of cutter is used in this holder the same as in the company's regular type, and the method of holding the cutter is also similar, there being a notched clamping bolt which engages and binds the cutter. These tools are not intended to take the place of the maker's other style of holder, but rather to supplement it, the two types being adapted to practically all the work done with solid tools.

NATIONAL SEMI-AUTOMATIC NUT-TAPPING MACHINE

The National Machinery Co., Tiffin, O., manufacturer of bolt, nut and forging machinery, has perfected a new design of semi-automatic nut-tapping machine. With this tapper, which we illustrate herewith, rough hot-pressed nuts are tapped as readily as cold-punched nuts, and the objections to the entirely automatic tapper, because of "sticking," etc. when



Semi-automatic Nut-tapping Machine, built by the National Machinery Co.

small burrs are encountered on rough hot-pressed nuts, is overcome.

The tap spindles are raised and lowered automatically, and the machine "sets the pace" for feeding. The operator does not experience fatigue, as on the foot-lever tapper, due to treadling, and he is enabled easily to keep pace with the machine throughout the entire working day, and secure the maximum output. It is claimed that the output secured with this machine is from 60 to 80 per cent greater than is possible

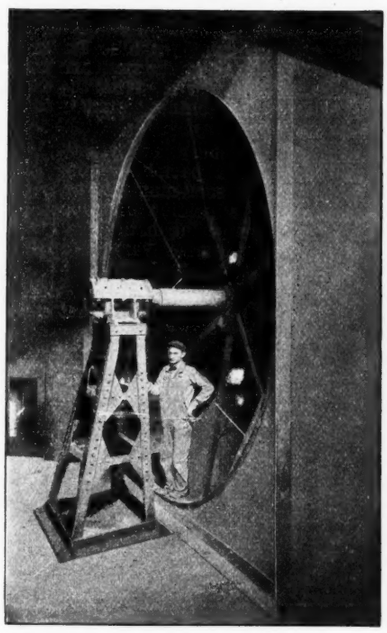
with the foot-lever tapper. The revolutions of the tap spindles, per raising and lowering, can be varied to correspond to the number of threads on the tap being used. This eliminates "non-productive" tapping time (tap running idle in the nut after it is tapped) and quickens the "pace" for feeding set by the machine. The variations in the revolutions of the tap spindles are secured through a single-lever quick-change speed box on the cam-shaft.

The raising and lowering of the tap spindles is accomplished by six three-step cams carried on a horizontal shaft in the rear of the spindle housing. These cams engage hardened steel rolls carried in the spindle levers. The cam-shaft shifts laterally so that the various cam faces or steps can be engaged, and in this way the "staying" or resting time of the tap, when raised, can be altered to meet the needs of the operator for feeding the machine and emptying the taps. The life of the tap, also, is longer, as a rule, than if used in the foot-lever tapper, as the cam movement causes the tap to lower gradually, and it does not drop into the hole with the weight of the spindle back of it, causing it to bind and resulting frequently in broken taps, stripping of the threads, etc.

An automatic socket is provided which allows the tap to be removed or inserted while the machine is running, and ejects the tap automatically when the shank becomes filled with tapped nuts. This new design is built in 1-inch capacity with six spindles, and 1½-inch capacity with ten spindles.

LARGE BUFFALO FAN

What is said to be one of the largest fans ever constructed has recently been made by the Buffalo Forge Co., Buffalo, N. Y. This fan is over 32 feet high, and it is being used in connection with a heating, ventilating and air conditioning system, supplying 25,000 cubic feet of air per hour to every employe in the new mill of the Sharpe Mfg. Co., New Bedford, Mass. This is the largest individual yarn mill in that city, and the company has given particular attention to the hygienic conditions. The air is washed before entering the mill, to remove all the dust, dirt and foreign matter, and make it absolutely clean. The arrangement is such that during the winter months the air can be heated to any desired temperature, there being independent regulation on each floor. Provision is also made for cooling the air, so that in the hottest days of summer the temperature throughout the mill, even in the spinning-room where the machinery generates an immense amount of heat, is from 15 to 20 degrees cooler than is possible with ordinary window ventilation. The volume of air that this large fan handles to achieve these results, reaches the astonishing total of 20,000,000 cubic feet per hour. The conditions obtained with this installation are as nearly ideal for a mill of this kind as it is possible to make them.



Mammoth Fan built by Buffalo Forge Co.

LANGELIER SWAGING MACHINE WITH A PNEUMATICALLY OPERATED HOLDER

The accompanying illustrations show a swaging machine manufactured by the Langelier Mfg. Co., Providence, R. I., that is arranged with a holder in which the feed of the work into the disks and the opening and closing of the chuck are operated by compressed air.

Fig. 1 shows this holder in position ready for use, and Fig. 2 shows it swung to one side in order to permit the removal and entering of dies and the inspection of the swaging parts of the machine. The holder consists of a cylinder, hinged to the cover of the swaging machine and supported at its outer end by a rail on which it rides when swung to the side. The main or cylinder piston actuates the feeding of the work into the dies and also its withdrawal, and an auxiliary piston operates the opening and closing of the chuck. These two pistons act independently of each other and both are controlled by a specially designed triple-action valve shown on top of the cylinder. The construction of the oscillating part of this valve is such that it compensates for wear and maintains a uniform pressure on its seat. The hand- and thumb-lever shown is used for operating this valve, the hand-lever controlling the feeding of the work into the dies and also its withdrawal, and the thumb-lever, the closing of the chuck. The chuck used is of the spring type.

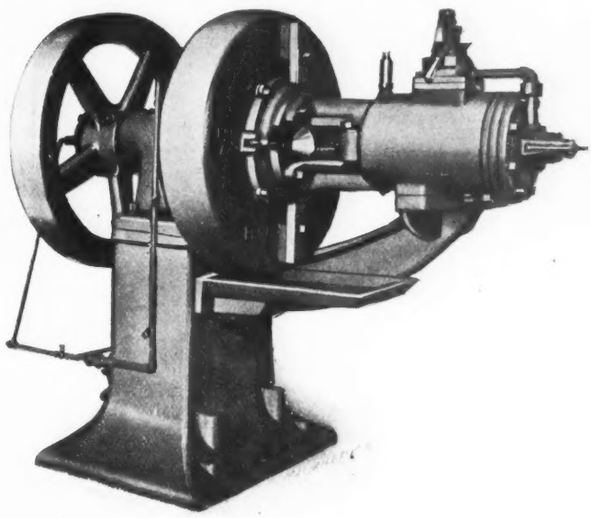


Fig. 1. Langelier No. 5A4 Swaging Machine, with Pneumatic Holder in Position for Use

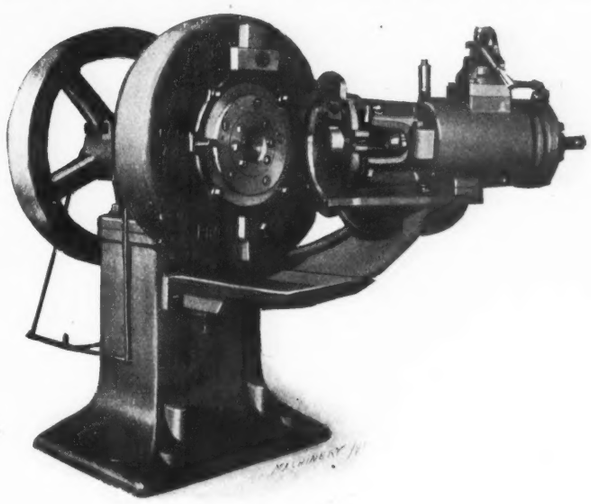


Fig. 2. Pneumatic Holder swung to One Side

The releasing of the chuck is automatically effected by the movement of the piston at the extreme end of its outer stroke by coming into contact with a piston valve provided for this purpose. By means of a trip lever on the end of the cylinder head, the chuck can be released at any part of the stroke. The inlet and outlet air connections are located in the rear of the valve.

An interesting example of swaging performed by this machine and holder, on brass tubing, is shown by the line illustration Fig. 3. To accomplish this work, it was necessary to use a separate chuck and pair of dies for each of the three operations illustrated, and also a swaging arbor for the second and third operations in order to obtain the thickness of wall as indicated by the outer and inner diameters. The brass tubing was cut into lengths as shown by the blank and the first operation reduced the diameter 5/16 inch. No swaging arbor

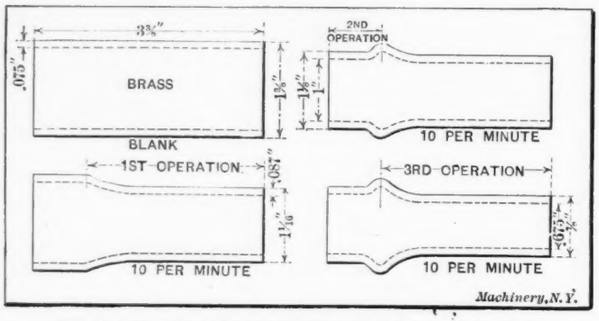
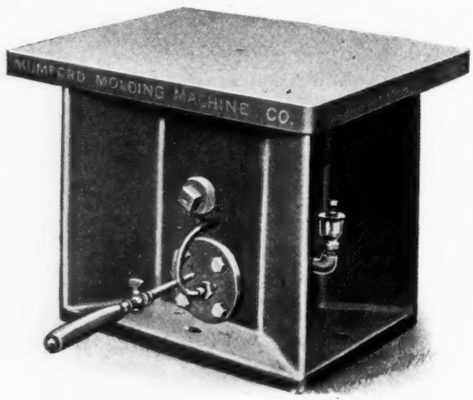


Fig. 3. Example of Swaging Operations performed on Machine illustrated in Figs. 1 and 2

was used in this operation as it was necessary to obtain as thick a wall as possible. The second and third operations show a reduction of ¼ inch and this swaging was done on an arbor located between the dies in the swaging head. The number swaged per minute, as indicated in the illustration, represents the actual performance, the time including the chucking and ejecting of the work.

MUMFORD CORE-BENCH JOLT-RAMMING MACHINE

The Mumford Molding Machine Co., 30 Church St., New York City, has added to its line the core-bench jolt-ramming machine shown in the illustration. This machine is particularly adapted to the ramming of deep cores of small dimensions made on the bench. It can be placed on a concrete pier, iron post or even a wooden one and affords a place on the core bench where any core adapted to such treatment can be rammed better and more economically than by hand. The starting and stopping of the machine is controlled by a knee-



Core-bench Jolt-ramming Machine built by Mumford Molding Machine Co.

valve under the bench so that both hands of the operator are free for handling material and core boxes.

While the rated lifting capacity of this machine is 300 pounds, with 80 pounds air pressure, it is more particularly adapted for small slender cores which, with the boxes, sand and all, weigh only a few pounds. The valve of this machine is simply a plug of casehardened machinery steel, having a 3/16-inch vertical stroke. Notwithstanding the simplicity of construction, the economy in the use of air is said to be superior to the more elaborate valve mechanisms. The table of this machine is 15 by 20 inches, the plunger is 3 inches in diameter, and the finished shipping weight is 325 pounds.

PAPER FILE HANDLE

The file handle shown in the accompanying halftone is made entirely of paper, excepting the steel ferrule at the end. The advantages of this paper handle are, that it will not split and is practically indestructible. A file tang is also held more firmly than in a wood handle, and tangs of a larger

Indestructible Paper File Handle

size than that for which a handle is intended, can be driven in without danger of splitting. The paper handles are cheaper than those of wood, and they can be obtained in various sizes. This new handle has been placed on the market by Schuchardt & Schutte, Cedar & West Sts., New York City.

NEW MACHINERY AND TOOLS NOTES

Knurling Attachment: Rivett Lathe Mfg. Co., Boston, Mass. Tailstock knurling attachment having a shank that fits the tailstock spindle and a slide with radial adjustment carrying two knurls. This slide is adjusted by a thumb-screw, and the shank of the tool is hollow to admit the work.

Core Machine: Midland Machine Co., Detroit, Mich. Jolt-rammed, roll-over core machine. Special design for making regular and special cores of various shapes and sizes. This machine is built in two sizes. It has a rise of 10 inches, which makes it possible to handle a large variety of work, both as a molding and core-making machine.

Pipe-Threading Machine: Williams Tool Co., Erie, Pa. Twelve-inch pipe-threading and cutting-off machine driven by direct-connected steam engine mounted at the rear and transmitting its power through machine-cut gears. With the exception of the change in the drive, this machine is similar to the No. 5 pipe-threader built by this company.

Furnaces: Tate, Jones & Co., Pittsburg, Pa. Three types of heat-treating furnaces, including a pack-hardening, case-hardening and annealing furnace; a semi-muffle furnace particularly adapted to hardening and annealing high-speed and carbon steel cutters, etc.; and a tempering bath that can be equipped with bath pots shaped to meet varying requirements.

Centering Attachment: Rivett Lathe Mfg. Co., Boston, Mass. Lathe centering attachment having a shank that enters the tailstock spindle, and a swiveling member that carries a drill and countersink. The pivot of the swiveling member is so located that either the drill or countersink can be brought into alignment with the spindle, the correct position being obtained by positive stops.

Pipe-Threading Machine: Murchey Machine & Tool Co., 4th & Porter Sts., Detroit, Mich. Single-head, motor-driven, semi-automatic, pipe-threading machine, similar in its general construction to the No. 2 double-head machine built by this company. The die-head is the maker's automatic opening type, and the capacity ranges from ½- to 2-inch pipe. This machine can be furnished with or without a motor.

Drilling Machine: Prentice Bros. Co., Worcester, Mass. Twenty-six-inch, geared-speed, large, upright drilling machine. All the bearings of this machine excepting those for the feed works are ball bearings, there being fourteen annular and one thrust ball bearing. The general design of this machine is similar to that previously built by this company. The advantage of the new construction is in the saving of power and increase of capacity.

Electric Welding Machine: Toledo Electric Welder Co., Cincinnati, O. Small machine designed for butt welding stock ranging from No. 16 gage wire to ¼-inch round iron or steel. The time required to place the stock in the jaws and complete a weld, is from three to five seconds. When welding small stock, the amount of current used can be reduced by a regulator which forms part of the equipment. This machine weighs about 100 pounds.

Cutting, Forming, and Horn Press: F. S. & G. L. Brown Machine Co., Baltimore, Md. Press having a bed or knee adjustable vertically on the frame or column to any desired position by means of a crank connecting through bevel gears with an elevating screw. The bed, when positioned, is rigidly clamped to the column. This type of press is also made with a hole through the frame in which a horn can be fitted, thus making a combination cutting, forming, and horn press.

DEPARTMENT PLAN MACHINE TOOL ARRANGEMENT ON BASIS OF PRODUCT*

By C. B. AUEL†

It will almost invariably be found that in the original design and lay-out of small and medium-sized manufacturing concerns, the tool equipment has been so arranged as to group together operations of a like kind, such as milling, planing, drilling, boring, screw machine work, etc.

The reasons for this are: (1) that for each of the principal machining operations, there is frequently but a single expert and in order to make the best use of this talent, no other scheme is permissible; and (2) that centralizing machines of a kind tends to decrease the number required for a given output. As a result of these there follow logically: (3) accuracy and speed in workmanship; (4) uniformity in methods; (5) economy in floor space; and (6) minimum distribution of power.

Under this method of production, a shop may be said to be divided into two portions, *viz.*, "feeder" and "assembly," the "feeder" sections making the parts from the raw materials and delivering them either to storerooms or to "assembly" sections where they are assembled into the complete apparatus preparatory to test and shipment. There will, in general, be a number of "feeder" sections, entirely independent of one another, and there may, likewise, be one or more "assembly" sections. A production, planning or routing department usually determines the manner in which orders are to be brought through, arranges delivery dates, keeps track of the orders as they progress through the shop, and exercises general supervision over production.

The East Pittsburg plant of the Westinghouse Electric & Mfg. Co., was operated, until about three years ago, along lines which may be said to have been departmentalization partly on a basis of tool equipment as outlined and partly on a basis of product during which time it met conditions fairly satisfactorily.

However, in any growing manufacturing concern, there comes a time when the advantages of the preceding arrangement are more than offset by the difficulties incident to its successful operation. The increase in volume of the semi-finished parts passing from "feeder" to "assembly" sections, with the accompanying increase of clerical and other work and the multiplication of foremen and superintendents concerned in the manufacture of any one class of product, results in delays and increased expenses of various kinds which cannot be overcome, nor can the recurrence of them be prevented. Perhaps the greatest drawback to such a scheme is the inability to fill orders promptly. This is especially apparent during periods of business depression when quick delivery is of greater importance than at any other time. The amount of stock on hand is then usually lowest and, accordingly, a larger percentage of apparatus requires to be built from the ground up to fill customers' orders. Under these circumstances, it becomes imperative to place so-called "rush," "forfeiture" and other orders of a like nature in a class by themselves and to conduct them personally, as it were, through the shop. In the doing of this, though, other orders are relegated to the background with consequent disastrous results, particularly in the matter of dissatisfaction on the part of the customers for whom such orders are intended. Of course, the greater the volume of these special orders, the greater the ensuing confusion and delay in connection with other orders, so that this method of procedure is not a solution of a difficult problem but simply a makeshift—a temporary expedient—to be abandoned as quickly as some more rational method presents itself. Another vital difficulty, perhaps equal in importance to that already mentioned, is the matter of divided responsibility, no one individual being primarily responsible for any complete piece or class of apparatus. Such being the case, it is exceedingly difficult to make even an attempt to ameliorate or to improve conditions which are known to need attention, for the reason that there seems to be no proper place at which to commence the betterment work.

As a result of these conditions and without going any more minutely into an analysis of the difficulties, it is reasonable to assume that in consequence of shipments being delayed and responsibility divided, "work in progress" and "stocks," raw and finished, will be high, and such proves to be the case.

Investigation Leading up to Adoption of New System

Recognizing that methods of manufacture which had in the past been satisfactory for their needs, were proving inadequate to handle the increasing volume of business, for the reasons already stated, the Westinghouse Electric & Mfg. Co. spent considerable time in investigating the methods of other large companies in similar lines of business with the result that it was believed advisable to modify the original scheme in favor of so-called "factory departmentalization"; that is, to divide the plant into a number of separate units, as self-contained as the nature of the work of each would permit; in other words, to treat the units like independent factories, as it were, housed together under the same roof for mutually advantageous purposes, yet buying from and selling to one another their various commodities as circumstances seem to make desirable. A scheme of this kind naturally causes a number of duplications of the organization and equipment. While this is so, it does not necessarily involve any material increase in either, since the change is more in the nature of a rearrangement of the existing equipment and organization, with the addition here and there of a few tools which, under the original plan, were used in common by two or more departments. Even this may be avoided to some extent by assigning such tools to the department requiring them most, and permitting the other departments to have their work done on requisition.

In introducing this scheme in the East Pittsburg works, it was deemed advisable as a precautionary measure to put it into effect in but one department only, further progress along this line to be dependent wholly upon the results obtained in it. This was accordingly done and with very gratifying results, almost from the very beginning. It was found, as anticipated, that among other advantages, shipments were facilitated and "work in progress" and "stocks" decreased, all to a very marked degree.

Comparing the routine in this particular department under the original and the modified plans, in the original the work was performed by twenty-two sections located in thirteen independent departments; in the plan as modified, the same work is now done by thirteen sections in seven independent departments. But this by no means emphasizes the difference even in the routine, for the reason that under the modified plan authority for an entire line of product is vested in a single individual, who, therefore, is enabled to exercise his discretion as to the raw and partly finished items to be carried. By a judicious selection of these, he has at all times a certain amount of stock on hand and is thus, to a large extent, not dependent in the matter of deliveries on the other sections outside of his authority which supply him with materials.

In consequence of the excellent showing made in the department selected for trial, departmentalization was gradually extended throughout the plant until now the work has been almost completed. Though not yet perfected, some of the details still requiring to be straightened out here and there, the general results have been a confirmation of those obtained in the department in which the scheme was first tried.

Of course it is hardly practical to carry this departmental idea into all sections; for example, in pattern shops and foundries, or in certain other places where either the work or the equipment is very special; neither has it been deemed wise to include disk grinding or polishing on account of the deleterious effect of the dust and fumes on other machines in the vicinity, though certain work of this kind is being done in some of the departmentalized sections where facilities for carrying off the dust and fumes have been provided.

Departmental Arrangement under the System

As at present arranged, there are in the works eight fairly self-contained departments as follows: (1) Railway, mining and crane motors; (2) power—for large generators and

*Abstract of paper presented before the semi-annual convention of the National Machine Tool Builders' Association, Atlantic City, N. J., May 19, 1911.

†Assistant manager of works, Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

motors; (3) control—for railway and industrial control apparatus; (4) detail—for switchboards and accessories; (5) small motor—for small power motors; (6) transformer; (7) locomotive; (8) industrial—for medium-sized motors. Besides these, certain "feeder" sections still continue: coils, punchings, blacksmith, cabinet and pattern-making, screw machine, foundries, etc. With respect to the screw machine section, it may be stated that this has been departmentalized to some extent, though the greater portion, for the manufacture of such parts as are made in large quantities and carried in stock by the central stores, remains unchanged. Regarding the other "feeder" sections, it is possible that some of them may in due course be departmentalized, without necessarily changing their present geographical location; but simply by assigning a certain proportion of the floor space and the tool equipment in each, to every one of the already departmentalized units.

Advantages of System

Summarizing the various advantages, they may be said to include: (1) centralizing of authority in the production of each class of apparatus; (2) decrease in time required to fill customers' orders; (3) increase in output in a given period; (4) decrease in "work in progress" and in "stocks"; (5) saving in floor space; (6) decrease in handling of materials; (7) decrease in clerical labor; (8) decrease in indirect expense or overhead burden; (9) increase in individual initiative; and (10) healthy competition between similar sections and departments.

In the matter of accounting, departmentalization has been carried even further than it has with the manufactured products, for every part of the works, whether a "feeder" section or a completely departmentalized unit, is now self-contained in this respect, making a total of fifty-three such units in all. These, being comparatively small, permit the ready compilation of the transactions of the preceding month, so that all intersectional and inter-departmental accounts are therefore balanced on a monthly basis. A further advantage of this feature is that each unit has its own percentage of indirect expense or overhead burden, figured on its total productive labor, which percentage is changed from time to time as circumstances seem to warrant. Order costs are compiled by the "feeder" sections and departments themselves. It may be stated that it is not the aim to show either a profit or a loss in any of the sections or departments so that when either of these conditions arises, the overhead percentage is altered accordingly. Every month each of the units in the works is provided with a set of charts or curves giving a continuous record of its performance in total productive labor, total expense labor and total expense materials, the expense items being also segregated along various helpful lines, all shown directly in dollars and cents, and many as a percentage of total productive labor as well. This percentage is considered as a measure of the expense labor and material efficiency.

* * *

AMERICAN MUSEUM OF SAFETY GRANTED A CHARTER

Friends of the movement for prevention of accidents in shops, mills and factories, workmen's compensation and improvement of industrial employment conditions generally—in short, the conservation of human life—will be glad to learn that the American Museum of Safety, New York City, has been granted a special charter of incorporation by the Legislature of New York State. The Museum of Safety is now in the same class with the Metropolitan Museum of Art and the American Museum of Natural History, both having special charters from the state.

The Museum has an interesting and valuable collection of protective devices in the Engineering Building, 29 West 39th St., New York, for many classes of machinery and working conditions. When it is considered that over 500,000 workers are annually killed or incapacitated by industrial accidents the importance of this practical philanthropic work will be appreciated. A conservative estimate of the yearly loss in cash wealth, due to these accidents alone, is $250,000,000.

DEPARTMENT PLAN MACHINE TOOL ARRANGEMENT ON BASIS OF EQUIPMENT*

By F. C. KENT†

Inasmuch as the product of some concerns is diversified, and machine tools used for one class of product would not be suitable for the manufacture of another class, this discussion on the merits of the departmental plan of arranging machine tools upon the basis of equipment as against the plan based upon production, would be applicable in its entirety to only about eighty per cent of our manufacturing establishments.

My earlier training in the metal work industries has been with the department plan of machine tool arrangement upon the basis of production, and the transition to an enthusiast of the department plan of machine tool arrangement upon the basis of equipment has been gradual.

It may be interesting to note that I have had a variety of subjects upon which to try out this proposition, *e. g.*, cheap metal specialties, bicycles, motor vehicles, electric locomotives, coal mining machinery and general jobbing and contracting work. The quality of workmanship and material has varied from the roughest to that of the very highest grade, and the weight of the finished product has ranged from a few pounds to many tons.

Some of these concerns were very thoroughly organized upon the basis of the product plan, but in every case where a change has been made to the basis of equipment there has been a decided increase in profits, together with a marked increase in wages of both productive and non-productive labor.

The remark that this is the age of specialization in the machine shop is true, but how many of us comprehend the truth? Manufacturers are just beginning to resolve into first principles the various manufacturing processes of their finished product. They have yet to apply this analysis with exactness to the problems of machine tool efficiency in the manufacture of their product. I believe there is a lack of knowledge of the possibilities of the most common type of machine tools in every shop; in fact, there is not one shop in ten in which the possibilities of even the engine lathe are thoroughly understood.

There is no doubt but that development along this line has been retarded by the system of arranging tools upon the basis of production. Department superintendents and foremen have had to cover too wide a field; their thoughts and energies have been distracted by the multiplicity of things needing attention every minute of the day. Some of you, who have been shop foremen in the past, must concede that there are a few things that need constant attention regardless of the system you may have devised to relieve you of the clerical and detail work. Furthermore, I believe it to be a physical impossibility for a foreman to produce a well-balanced and maximum product with machine tools grouped on the basis of production. A few words from an editorial in the *Motor Age* of March 30 will illustrate this point with respect to the operator.

"The arrangement of machinery was not symmetrical, drills were placed side by side with planers, and planers with lathes, and lathes with grinders. It was discovered that this mixing of operators brought about an unconscious confusion in the mind of the workman. The workman at the lathe might be a master of his job, but his energies were not concentrated on it. One minute he was watching a grinder at his right, the next a drill at his left, with the result that his efficiency was impaired and it was impaired because of distracting environments."

Now, if the operator's mind becomes distracted under such conditions when he has nothing to think of but his machine and the subject he is machining, what must be the state of mind of the foreman of this department?

A foreman as well as an operator has his "hobby," and if he did not ride it he would not be human. He may be fascinated with the lathe, but despise the sight of a grinder. The operations on the lathe will receive his best attention whether the work done on the other types of machines needs super-

*Abstract of paper presented before the semi-annual convention of the National Machine Tool Builders' Association, Atlantic City, N. J., May 19, 1911.

† Superintendent, Pierce Arrow Motor Car Co., Buffalo, N. Y.

vision or not, in spite of the fact that he may be the so-called "all-around" mechanic. He is more or less a jack-of-all-trades, flitting from one job to another without learning the real possibilities of any of the machines under his charge. These conditions preclude thinking of labor and machine efficiency as applied to his department.

For general supervision, the plan of grouping the machines upon the basis of production is disastrous in most factories because of the impossibility of effecting a working balance between the various operating departments and of making the production equal in all departments. The grouping of machine tools upon the basis of equipment is the only solution for better and increased production. This is true because no man becomes an expert in all lines of mechanics. He increases production because he intensifies or specializes along narrow lines. The foreman who concentrates his energies upon one class of machine tools, and is alive to the possibilities of his equipment, has the opportunity of his life for increasing to the highest degree the labor and machine efficiency of his department.

The problem of securing proper departmental supervision becomes less serious under the system of grouping machines according to equipment rather than according to production. I have seen foremen in charge of departments equipped with lathes, drills, grinders, etc., who were unable to get satisfactory results, but when these same men were placed in charge of one special class of work with machines with which they were entirely familiar, they became so interested and enthusiastic with the result, that their earning power and efficiency were greatly enhanced.

Nor is it only where the human element is concerned that the plan of grouping machines with regard to equipment is superior to the plan of grouping with regard to the product; it has been demonstrated that less permanent investment is needed because less floor space is required. Consequently it admits of a better lighting system and requires fewer lights and less heating apparatus. The saving in pulleys, hangers, shafting, belting, etc., is considerable. Power, labor and supplies for the up-keep of the extra equipment are also saved.

In fact, on several occasions the rearrangement of machinery to the plan based upon equipment has saved the necessity of erecting new buildings to increase production. In one change, I recall that 110 hangers, and other power transmission equipment in proportion, were eliminated. When machines of the same type are grouped together it is possible to discern their productive capacity and set an efficiency standard with greater accuracy. It also assists the foremen in selecting the better types of machine tools and in eliminating the poorer ones.

Organized upon the basis of product, there is a tendency of department foremen to carry a stock of their own jigs, chucks of various sizes, milling machine and lathe arbors, drills, taps, dies and cutters of all sorts which are frequently duplicated in other departments. The diversity of opinions among foremen about high-speed steels, emery wheels, etc., is accountable for the great variety found in so many manufacturing plants organized on this plan.

This duplication and confusion incident to the handling of small tools and apparent lack of exact knowledge may be obviated by the installation of a central tool storage, equipped with first-class grinding facilities and supervised by a tool specialist. By this method, worn tools may be properly ground and kept in perfect condition, ready for use when needed. This arrangement makes possible the standardization of emery wheels, sizes of tool steel and all kinds of shop supplies.

At the Pierce-Arrow Motor Car Co. the arrangement of machine tools on the basis of equipment is carried out to a much greater degree of refinement than at most shops operating under this system. All lathes are not only grouped to form a department, but they are subdivided into smaller groups according to size, class of work, etc. For instance, one section known as the "turret department" is divided into groups of automatic chucking machines, automatic screw machines, flat and hexagon, turret lathes and hand screw machines. The larger turret lathes of the Gisholt type and vertical boring tools are not included in this department, but form separate groups. The hand and spur gear-cutters form separate groups. The milling machines are classified as vertical, horizontal, Lincoln type and hand groups. The drilling machines are divided into radial, heavy-duty, medium and sensitive groups. The grinders are grouped as internal, plain and surface. Supervision is effected by placing an assistant foreman in charge of a subdivision of machines. He is responsible to the foreman who has direct charge of the departmental group. The foreman is under the direct supervision of a general foreman or assistant superintendent, of which there are several. They, in turn, receive their instructions from the general superintendent.

In our production engineering department, which has been instituted for the purpose of effecting a more closely related shop organization, we now have a working force of three mechanics and three clerks; the former have been in the employ of the company for a number of years and understand our product thoroughly. The head of the department has served as draftsman, tool designer, head of specification, pattern and material order departments, and is intimately acquainted with the materials used in our product. The second is a patternmaker, designer of special machinery and tools, and is also a machinist. The other is an expert toolmaker, former tool-room foreman, and has had considerable experience in the manufacture of special machinery.

A "suggestion blank" pad is to be found on every shop foreman's desk. These blanks are used by the foremen and his men for the purpose of bringing to the attention of their department such changes in manufacturing operations and handling of our product as occur to them from time to time. The suggestions are carefully analyzed by this department, and if no objections to their adoption are found by them or by the department superintendent, by whom the suggested changes are finally approved, the changes are made. On the other hand, if the suggested changes are rejected, the reasons therefor are reported to the men who make them.

When new parts for our production are determined upon, this department, with the assistance of the shop foreman interested, carefully analyzes the operations necessary for each part, so as to assist our chief tool draftsmen in determining correct working points in making quick-acting and economical tools.

* * *

The Woolworth building, which will be erected on Broadway between Park Place and Barclay St., will be the world's greatest sky-scraper and highest structure, barring the Eiffel Tower in France. It will be 750 feet high or 50 feet higher than the tower of the Metropolitan Life Insurance Co.'s building, and 138 feet higher than the Singer Tower, and will have a frontage on Broadway of 152 feet, 197 feet on Park Place, and 192 feet 6 inches on Barclay St. The tower part of the building is 86 by 84 feet. The main structure will be twenty-nine stories high, and with two stories in the gables, thirty-one stories at the highest point of the main structure. The total number of stories is fifty-five, and thirty-four elevators will be provided to serve them. The cubic contents of the building exceed 13,200,000 cubic feet. The foundation work is the greatest piece of caisson work yet done in New York City, and will cost about $1,000,000. The caissons extend down to solid rock at a distance of 110 to 130 feet below the street. The plot of land cost about $4,500,000, and the cost of the building and foundation is placed at another $4,500,000, making the total cost about $9,000,000. The building will be completed in the fall of 1912.

* * *

The Union Steel Casting Co. of Pittsburg, Pa., has experimented considerably with vanadium steel castings. It has been found that steel castings containing about 0.2 per cent of vanadium show a great increase in tensile strength and elastic limit. Castings have been made by this company having a tensile strength of 90,000 pounds per square inch; the average tensile strength, however, is about 80,000 pounds, and the elastic limit about 45,000 pounds.

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION CONVENTION

The nineteenth semi-annual convention of the National Machine Tool Builders' Association was held in Atlantic City, May 18-19 at the Marlborough-Blenheim Hotel; the presiding officers were: President, F. A. Geier; and secretary, Charles L. Hildreth. The meeting was fully up to the mark set by previous Spring meetings, both in the character of technical papers presented and in the number of the membership present. A spirit of optimism pervaded notwithstanding the depression affecting the trade for the past year or two, and expressions of confidence in the resumption of normal business in the near future were heard.

On opening the meeting, Mr. Geier referred to the trials and tribulations of the machine tool business during the time of dull trade, and expressed the thought that the recent Supreme Court decision in the Standard Oil Co. case would clear away the uncertainty that had unsettled the business conditions of the country. The time was opportune for carefully examining present methods and making plans for securing greater efficiency generally.

The secretary, whose able work has so strengthened the association, spoke strongly of the need of eliminating all sectional feelings and prejudices. These are harmful in business, and one of the chief functions of the association is the forming of pleasant business relationships and cementing friendships between men, irrespective of the locations of the concerns represented. The secretary is revising a segregated list of machines built by the members, and his intention is to inject a personal element into the membership list by including the names of men prominent in the respective companies.

The condition of the association is prosperous. With an ample balance of funds on hand and an increasing membership, its prospects are bright. Twelve concerns were added to the association at this meeting, as follows:

Brown & Sharpe Mfg. Co., Providence, R. I.
The Burke Machinery Co., Conneaut, Ohio.
The Cincinnati Gear Cutting Machine Co., Cincinnati, Ohio.
Cochrane-Bly Co., Rochester, N. Y.
Higley Machine Co., Croton Falls, N. Y.
The Massilon Foundry & Machine Co., Massilon, Ohio.
Meisselbach-Catucci Mfg. Co., Newark, N. J.
The Miami Valley Machine Tool Co., Dayton, Ohio.
Steinle Turret Machine Co., Madison, Wis.
The Standard Mfg. Co., Bridgeport, Conn.
The Stoever Foundry & Mfg. Co., Myerstown, Pa.
The United States Electrical Tool Co., Cincinnati, Ohio.

The name of the Grant & Wood Mfg. Co., Chelsea, Mich., having been changed to Flanders Mfg. Co., the membership was transferred to the new name. The business of George W. Fifield, Lowell, Mass., lathe builder, is being wound up on account of the death of the president, Mr. George W. Fifield, and the resignation of the concern was accepted.

Mr. C. L. Taylor of the Taylor-Fenn Co., Hartford, Conn., chairman of the patent committee, reported the failure of Congress to provide for the establishment of the special court for patent appeals that is so urgently needed to handle patent causes efficiently and relieve the congestion of patent litigation. The committee was continued.

Mr. C. H. Norton of the Norton Grinding Co., Worcester, Mass., read the brief report of the committee appointed to prepare a list of machine tool users for the common use of the members for circularizing purposes. It has been found impracticable to carry out the plan because of the reluctance of members to turn in their valuable private lists, when many of the members have no lists of importance to contribute.

Mr. George J. Burns, of the Chandler Planer Co., Ayer, Mass., gave a strong talk on the great need of an American merchant marine. He denounced the great shipping trust that throttles competition and dictates terms to shippers, railways and other factors of international trade. Mr. Burns believes the only way to restore the American flag to the seas is to support our shipping by a liberal subsidy, wisely safeguarded.

Mr. Fred L. Eberhardt of Gould & Eberhardt, Newark, N. J., read a short but interesting report on the definition of "machine tools." The difficulty of precisely defining the term in general terms commonly understood is great, if not almost insuperable, but the need of a definition that will be generally accepted by the trade and the governments of the world is conceded by all. On the motion of Mr. Murray Shipley of the Lodge & Shipley Machine Tool Co., the committee was instructed to confer with a committee appointed by the American Society of Mechanical Engineers to define common mechanical terms.

Mr. C. Wood Walter of the Cincinnati Milling Machine Co., Cincinnati, Ohio, chairman of the committee on cancellation of orders reported gratifying progress in securing the cooperation of members and other associations. Eighty-four of the members are now using the standard clause: "All proposals, quotations and acceptances of orders are made with the mutual understanding that orders are not subject to cancellation, provided shipment is made within the time promised," in their contracts, printed matter, etc.

The committee on incorporating the association, of which Mr. Rufus King of the King Machine Tool Co., Cincinnati, Ohio, was chairman, reported against the proposal to incorporate.

The following excellent papers and addresses were presented to an appreciative audience:

"Department Plan of Machine Tool Arrangement on the Basis of Equipment," by F. C. Kent, superintendent of Pierce-Arrow Motor Car Co., Buffalo, N. Y.

"Department Plan of Machine Tool Arrangement on the Basis of Product," by C. B. Auel, assistant works manager, Westinghouse Electric & Mfg. Co., Pittsburg, Pa.

"The Principles of Scientific Management," by Fred W. Taylor, past president of the American Society of Mechanical Engineers and general manager of the Tabor Mfg. Co., Philadelphia, Pa.

"The Proper Distribution of Expense Burden," by A. Hamilton Church, certified accountant, Boston, Mass.

"Employer's Liability and Worker's Compensation," by F. C. Schwedtman, chairman, Citizens' Industrial Association of St. Louis, St. Louis, Mo., and James A. Emery, counsel National Association of Manufacturers, Washington, D. C.

* * *

NATIONAL ASSOCIATION OF MANUFACTURERS CONVENTION

The sixteenth annual convention of the National Association of Manufacturers at the Waldorf Astoria, New York City, May 15, 16 and 17, 1911, proved a decided success both in point of view of attendance and quality of matter presented before the association in the form of reports of committees and original papers.

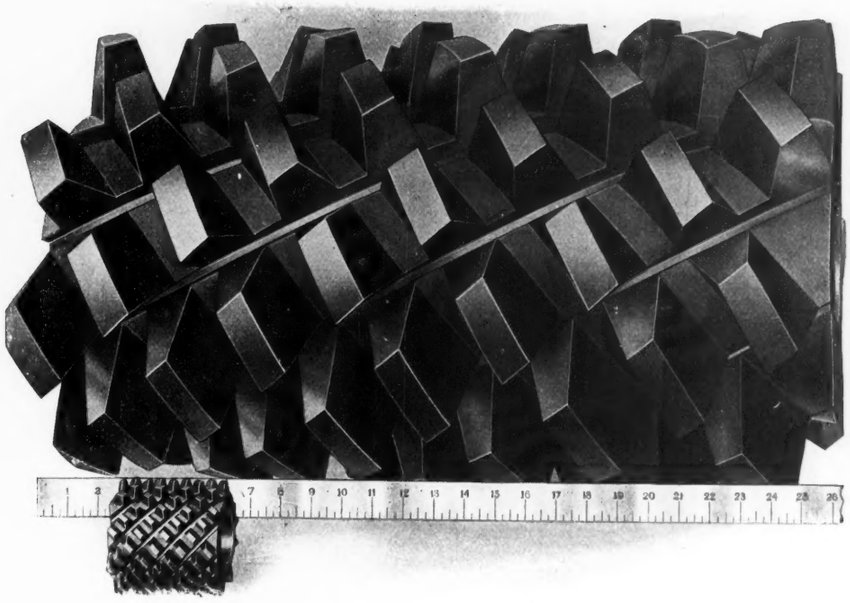
The reports of Messrs. F. C. Schwedtman and James A. Emery were the main feature of the convention, for in these two papers was given the pith of the investigations conducted by these gentlemen during the past year on the European continent as commissioners from this association, analyzing European systems of industrial indemnity insurances. Mr. Schwedtman dealt with the practical side of the question, touching the advisability of the systems investigated, while Mr. Emery, as a lawyer, dealt with the legal phases of the subject and the legality of introducing such a system on the basis of general taxation.

Before outlining the systems operative throughout Europe, more particularly the ones in Germany, the speakers pointed out how the United States is behind other large countries in the matter of considering such a scheme. That public sentiment has been awakened is evidenced by the fact that upward of two hundred workmen's compensation bills have been before different legislatures in this country during the past six months, many of them having been adopted.

In Germany the mutual organization prevails, and every employer is compelled to belong. Power is invested in them to enforce the rules and they are subject to heavy fines should they fail in so doing. The businesslike manner in which the organizations are handled was forcibly brought out when it was mentioned that the average cost of administering these funds in Germany is only 12.8 per cent, while in the United States the injured party only receives on the average from 20 to 30 per cent of that which is due him, the balance being principally eaten up in litigation. As a means of keeping the workmen interested in the system the principle of

B & S HOBS

SPUR OR WORM GEAR



The manufacture of accurate hobs is a difficult task and cannot be accomplished by the aid of special facilities alone. Long experience, together with specially designed machines for cutting and relieving the hobs, is a necessity. So, also, are special machines needed for grinding, but unless properly hardened, accuracy and durability cannot be obtained. Here experience counts, for each hob must be treated differently according to the size, hole, length, etc.

We have had more than 20 years' experience in making hobs.

BROWN & SHARPE MFG. CO.

PROVIDENCE, R. I., U. S. A.

workmen's compensation was deemed the better, for by taking the employe into a co-partnership, an increased feeling of responsibility is created in the latter.

A number of committees, appointed by the association in the convention last year, made their various reports on the subjects which they had been commissioned to investigate. These reports—many of them lengthy—contained much information of vital importance to the country in general and to manufacturers in particular. Representative men presented the various addresses on important subjects, among which might be mentioned the paper on "Industrial Education," by Prof. Arthur A. Hammerschlag, director of the Carnegie Technical School.

At the elections on the last afternoon, John Kirby, Jr., was re-elected president of the association.

* * *

BALL-BURNISHING

A smooth surface may be produced on metals in two ways, *viz.*: by reducing the high spots by abrasion, or rubbing them down with a hard substance under pressure. The first-mentioned is the ordinary polishing method, while the second is the burnishing process.

The steel ball burnishing process consists in tumbling the articles together with a comparatively large number of steel balls in a tumbling barrel provided with a proper lubricating solution. For satisfactory results an especially designed barrel and hardened steel balls are required.

The barrel made by the Globe Machine & Stamping Co., Cleveland, Ohio, is made with proper regard for expeditious work. This company's barrel is of large diameter and short length which is advantageous in concentrating a much greater weight of balls on a given surface than would be possible in a long shallow barrel of the same holding capacity. The lubricating material is a mild soap solution and bright clean surfaces are produced, which are satisfactory for plating purposes. Curved and intricate surfaces are easily treated by simply varying the sizes of the balls.

For small articles such as saddlery, cabinet and trunk hardware, pipe fittings, stove parts and stampings, or similar pieces which are used by manufacturers in large quantities, the burnishing process is very successful in producing a hard, smooth and highly-polished surface. In addition, this finish is obtained without the removal of any material or without the necessity of the separate handling of each piece that would be required in the polishing process. One man can handle several burnishing barrels, treating hundreds of pieces per day.

* * *

DRILLING INDEX PLATES

At the Owen Machine Tool Co., Springfield, Ohio, a rapid and convenient method is used for drilling the holes in the index plates for milling machine index heads. The holes are drilled in a Brown & Sharpe gear cutter. The index plate is mounted in a vertical position on the gear cutter head spindle, and a special device is placed on the cutter slide for holding and driving the drill. This device consists simply of a pulley for a round belt, placed on a shaft connected by bevel gearing to the drill spindle, which, of course, is horizontal. As all the movements for automatically drilling and indexing the index plate are provided on the gear cutting machine used, it is only necessary to start the machine, which will automatically stop when one series of holes has been drilled. Then the operator simply raises the head for the next circle of holes, provides the gears for proper indexing, and sets the machine going, and so on.

* * *

PERSONALS

A. N. MacFarland has taken charge of the advertising department of the Crocker-Wheeler Co., Ampere, N. J. Mr. MacFarland assumed his duties May 1.

F. G. Brown has resigned the position of tool-room foreman of the Packard Motor Car Co., to become manager with E. J. Kruce & Co., Detroit, Mich., contracting toolmakers and machinists.

Edward F. Croker, ex-chief New York fire department, has taken the chairmanship of the section of the American Museum of Safety, New York, on fires, fire prevention and apparatus.

E. Lichtenberg, draftsman and designer for the Whitman & Barnes Mfg. Co., Chicago, Ill., has resigned to become chief draftsman and mechanical engineer of the Koehring Machine Co., Milwaukee, Wis.

J. W. Bryce, draftsman with the Blickensderfer Mfg. Co., Stamford, Conn., has resigned to take a similar position with the B. L. Co., of Norwich, Conn., manufacturer of ball bearings; he assumed his new duties May 22.

Frederick Hughes, for the past six years chief engineer for the Driggs-Seabury Ordnance Corp., of Sharon, Pa., has joined the engineering staff of the New Departure Mfg. Co., of Bristol, Conn., manufacturer of ball bearings.

Charles W. Cade recently resigned as foundry manager of the Blake & Knowles Steam Pump Works, East Cambridge, Mass., which position he had held for the last eight years. Mr. Cade is at present engaged in consulting work.

O. E. Clark has been promoted from the position of tool designer and draftsman to that of superintendent of the Denver Rock Drill & Machine Co., Denver Col. Mr. Clark succeeds Mr. A. C. Brown, formerly of the Remington Arms Co., Ilion, N. Y.

Walter B. Snow, publicity engineer, 170 Summer St., Boston, Mass., has recently added to his staff, John S. Nicholl, late of the New York Edison Co., and formerly acting manager for F. W. Horne, importer of American machinery, Yokohama, Japan.

Charles L. Gulley has taken the position of manager of the power apparatus and fire alarm installation department in the Toronto office of the Northern Electric & Mfg. Co., Montreal, Can., leaving his position as senior demonstrator in electricity at the University of Toronto for that purpose.

Hardy S. Ferguson, for several years chief engineer of the Great Northern Paper Co., is now established as an independent consulting engineer at 200 Fifth Ave., New York. He will devote himself particularly to engineering work in connection with paper, pulp and fiber mills, including buildings and complete mechanical equipment, etc.

E. G. Eldridge, formerly with the E. L. Essley Machinery Co., Chicago, Ill., has opened a store at 566 Washington Blvd., Chicago, Ill., for the sale of new and second-hand machine tools. Mr. Essley was with the McDowell & Stocker Machine Co. prior to his connection with the E. L. Essley Machinery Co. which dates from the inception of the latter.

Wolcott Remington, well known as a designer and manufacturer of oil engines, has associated himself with the Blanchard Machine Co., Cambridge, Mass. He is now engaged in getting out for them a line of stationary and marine oil engines ranging from 10 to 100 H. P., which will be manufactured under the name of the "Blanchard oil engine."

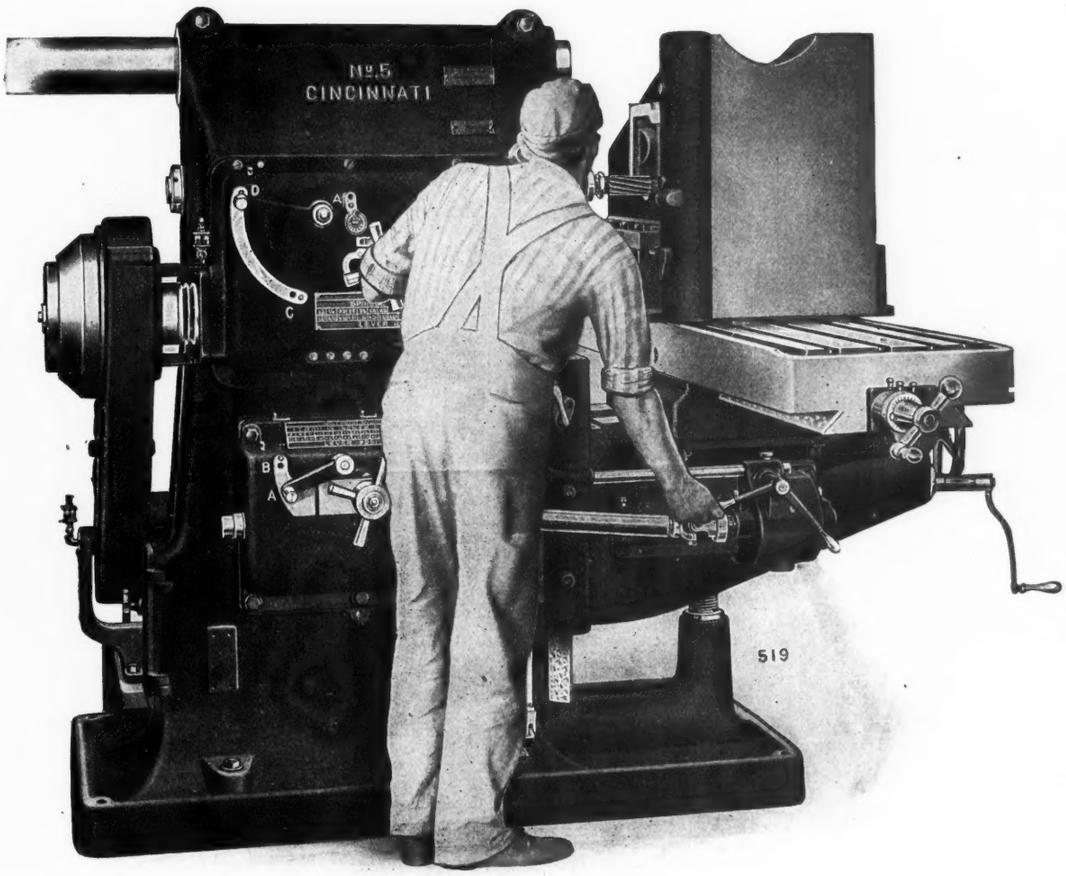
Gordon C. Keith, for several years managing editor of *Canadian Machinery*, the *Power House* and *Canadian Foundrymen*, resigned from the MacLean Publishing Co., May 1, to take a similar position with the *Canadian Manufacturer* as editor of that paper. Mr. Keith's wide experience in responsible positions should prove very valuable to this representative Canadian paper.

Henry R. Cobleigh, for the past seven years mechanical editor of the *Iron Age*, has resigned to take the position of publicity manager for the International Steam Pump Co., 115 Broadway, New York. Mr. Cobleigh was a publicity man prior to his connection with the *Iron Age*, and the experience acquired in the conduct of a first-class mechanical journal has well fitted him for his present responsible place.

W. J. Kaup, who since 1898 has been in charge of the department of machine construction of the Pratt Institute, Brooklyn, N. Y., has resigned to become production engineer with the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa. Mr. Kaup is a man of remarkable resource and versatility. He started work, after taking a high school course, as a telegraph messenger, and has been an operator, railroad man, machinist, toolmaker, draftsman, inspector, organizer, lecturer, instructor and consulting engineer. He is a "live wire" and an inspiration to his classes, having the faculty of making men ambitious to succeed. He spent three months last summer making a report on the production methods of the company by which he is now employed.

Frederick A. Halsey, editor-in-chief of the *American Machinist*, resigned the position May 1 on account of ill-health, and was succeeded by Mr. L. P. Alford, who has been the engineering editor for several years. Mr. Halsey is the originator of the premium system of rewarding labor, in use in American and foreign manufacturing plants under that and various other names, the basic principle being a piecework plan under which the workman is guaranteed his regular day's pay and additional payment for production in

Cincinnati Handiness



WHEN you have a job of end or face milling to do on a Horizontal Miller, don't you find it hard to operate the feed lever and at the same time keep your eye on the cutter? That's because the machines you are using can be operated from only one place. Our new High Power Machines have an additional feed lever at the side of the knee.

The operator can stand close up to his work, with the cutter in full view, and control the machine from this position.

With this one lever he can operate and reverse table, cross or vertical feeds.

The main starting lever is immediately in front of him and the speed and feed changers are at his elbow, so that the entire machine is under complete control from here. *Ask for the Catalog.*

The Cincinnati Milling Machine Company

Milling Specialists **CINCINNATI, OHIO, U.S.A.**

EUROPEAN AGENTS—Alfred H. Schutte, Cologne, Brussels, Milan, Paris and Barcelona. Donauwerk Ernst Krause & Co., Vienna, Budapest, Prague and Berlin. Chas. Churchill & Co., London, Birmingham, Manchester, Newcastle-on-Tyne and Glasgow. CANADIAN AGENT—H. W. Petrie, Limited, Toronto, Montreal and Vancouver. AUSTRALIAN AGENTS—Thos. McPherson & Son, Melbourne. JAPAN AGENTS—Andrews & George, Yokohama. CUBAN AGENT—Adolfo B. Horn, Havana. ARGENTINE AGENTS—Adolfo Mantels & Co., Buenos Ayres.

excess of certain specified amounts. He is an ardent opponent of the metric system, and was prominent in the organized opposition to it a few years ago, when a bill was introduced in Congress to substitute that system on government work for the present English system of weights and measures. An outcome of the agitation was the book "The Metric System Fallacy," by Halsey and Dale. Mr. Halsey is also the author of "Worm and Spiral Gearing" and "Locomotive Link Motion."

* * *

OBITUARIES

Alexander E. Brown, president of The Brown Hoisting Machinery Co., Cleveland, Ohio, died April 26.

Ferd. Herold, builder of the first steel hull boat on the Mississippi river, died at his home in St. Louis Mo., May 1, aged eighty-two years.

Edwin S. Stacy head of the Stacy Machine Co., Springfield, Mass., died at his home in that city April 30, aged seventy-two years. Mr. Stacy established the business bearing his name forty-five years ago.

J. W. Kissick, the foundry superintendent of the Columbus Iron Works Co., died at his home in Columbus, May 11, aged sixty-four years. Mr. Kissick had been connected with the Columbus Iron Works Co., as foundry superintendent for twenty-six years, and was well known to foundrymen throughout the country.

* * *

COMING EVENTS

May 30-June 2.—Spring meeting of the American Society of Mechanical Engineers at Pittsburg, Pa., headquarters, Hotel Schenley. Local committee, E. M. Herr, chairman; Elmer K. Niles, secretary; office of local committee, 2511 Oliver Bldg., Pittsburg. The professional sessions will be held in the lecture hall of the Carnegie Institute, near the headquarters, Wednesday morning and evening, and Thursday and Friday mornings. A number of inspection trips to various industrial plants in the vicinity have been planned. Calvin W. Rice, secretary, 29 West 39th St., New York.

June 14-16.—Annual convention of the American Railway Master Mechanics' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 14-21.—Annual convention of the Railway Supply Manufacturers' Association, in conjunction with the American Railway Master Mechanics' and Master Car Builders' Association, Atlantic City, N. J. J. D. Conway, secretary, 2135 Oliver Bldg., Pittsburg, Pa.

June 15-17—Annual summer meeting of the Society of Automobile Engineers at Dayton, Ohio, headquarters, the Algonquin Hotel. A number of valuable papers will be presented. Coker F. Clarkson, general manager, 1451 Broadway, New York City.

June 19-21.—Annual convention of the Master Car Builders' Association, Atlantic City, N. J. Joseph W. Taylor, secretary, Old Colony Bldg., Chicago.

June 20-23.—National Gas and Gasoline Engine Trades Association convention, Hotel Pontchartrain, Detroit, Mich. Albert Stritmatter, secretary, Cincinnati, Ohio.

October 9-13.—Annual convention of the American Electric Railway Association at Atlantic City, N. J. H. C. Donecker, secretary-treasurer, 29 West 39th St., New York.

SOCIETIES AND COLLEGES

COLUMBUS TRADE SCHOOL, Columbus, O., has issued a pamphlet entitled, "Cooperative Industrial Education," which embodies a plan for trade school work in that town.

DAVID RANKEN, JR., SCHOOL OF MECHANICAL TRADES, St. Louis, Mo., has just issued its first annual catalogue describing the general aim, scope of work and other information relative to tuition, etc. The courses are described in detail, and appear to be very thorough in their range.

UNIVERSITY OF WISCONSIN, Madison, Wis. The eleventh annual session of the summer school of engineering, under the direction of the College of Engineering of the University of Wisconsin, opens June 26, continuing for six weeks. Regular and advanced courses are offered in direct and alternating currents, hydraulics, machine design, descriptive geometry, applied mechanics, shop work, steam and gas engineering and surveying. Elementary courses adapted to the requirements of those not having preparation for the advanced work are offered in mechanical drawing, machine design and shop work, in addition to which opportunity is offered for laboratory work in the electrical, steam and gas laboratories for those who have had power plant experience or correspondence instruction. The teaching staff is taken from the regular instructional force, and all laboratory equipment of the engineering college is available for students. For bulletin or further information, address F. E. Turneaure, dean, College of Engineering, Madison, Wis.

NEW BOOKS AND PAMPHLETS

A GENERAL FORMULA FOR THE SHEARING DEFLECTION OF BEAMS. By S. E. Slocum. 25 pages, 6 by 9 inches, paper. Illustrated. Published by the J. B. Lippincott Co., Philadelphia, Pa.

This pamphlet, developing a formula for the shearing deflection of beams of arbitrary cross-section, either variable or constant, written by Prof. Slocum of the University of Cincinnati, is a reprint of the original article which appeared in the April issue of the *Journal* of the Franklin Institute. It is a highly mathematical treatment of the subject, and some very interesting deductions are drawn, a general formula being finally deduced. A numerical application of the formula to a planer cross-rail is included.

MONOPLANES AND BIPLANES. By G. C. Loening. 323 pages, 6 by 8 inches. Illustrated. Published by Munn & Co., Inc., 361 Broadway, New York. Price, $2.50.

Aviation, though still in its infancy, seems to have afforded a particularly fine field for writers, judging by the number of books on the subject that have made their appearance. This is doubtless due to the predominant place aviation occupies in the mind of the public. The writer of this book undertook the task with the conviction that a treatise, neither too technical nor too general, is required, and most of the books already published have not met this requirement. This book would appear to be well adapted to meet the wide demand for a practical work, for only such theory is embodied as comes in direct relation to actual aeroplane design. Much of the work involved in the writing of the book was performed for a thesis at Columbia University. The chapters are as follows: Historical Introduction; The Resistance of the Air and the Pressure on Normal Planes; Flat Inclined Planes; The Pressure on Curved Planes; The Frictional Resistance of Air; the Center of Pressure on Flat and Curved Planes; The Effect of Depth of Curvature and Aspect Ratio upon the Lift and Drift of Curved Planes; Numerical Example of the Design of an Aeroplane; Definitions; Important Types of Monoplanes; Prominent Types of Biplanes; Comparison of the Prominent Types; Controlling Apparatus; Accidents; and The Variable Surface Aeroplane. The book is profusely illustrated.

POWER. By Charles E. Lucke. 304 pages, 5½ by 7½ inches. Published by The Columbia University Press, Lemcke and Buechner, agents, 30-32 W. 27th St., New York. Price, $2.00.

This book by Prof. Lucke, the well-known power-plant engineer, consisting of the Hewitt lectures arranged in book form, is unique. It is not intended to be a text-book explanatory of the operation of the different types of power, but rather, has in view the pointing out of the enormous effect the substitution of mechanical power for hand and animal labor has had on the organization of society and the conditions of living. This is accomplished by the presentation of the development of power machinery to show what sort of ideas have produced this result. Thus, the bulk of the subject matter is concerned with the apparatus and machinery for converting natural energy in any of its available forms into useful work. The theoretical machine of any group is first given, followed by numerous illustrations of large installations of various sources. It is an interesting book, intelligible and instructive to engineer and layman alike. The chapters are as follows: The Relation of Mechanical Power and Machinery to Social Conditions; Means Employed for the Substitution of Power for the Labor of Men; Essential Elements of Steam-Power Systems; Principles of Efficiency in Steam-Power Systems; Processes and Mechanism of the Gas-power System; Adaptation of Fuels for the Use of Internal Combustion Engines; Water-power Systems and Basal Hydraulic Processes; and Social and Economic Consequences of the Substitution of Power for Hand Labor.

THE PRODUCTION OF MALLEABLE CASTINGS. By Richard Moldenke. 125 pages, 6 by 9 inches. 35 illustrations. Published by the Penton Publishing Co., Cleveland, Ohio. Price, $3.00.

It is only at rare intervals that information of unusual value is made the common property of the engineering public through the medium of a text-book on the subject; this book happens to be one of those rare instances. It enjoys the unique position of being the first and only book ever issued on the subject, and in it are made known many of the secrets of malleable iron practice. Nothing need be said with regard to the authorship, for Mr. Moldenke is so well known in foundry circles through his untiring zeal for the American Foundrymen's Association that his authority cannot be questioned. That such a book has not appeared before is all the more remarkable when it is considered that the production of malleable iron castings has been more or less known to the trade for many years. though such knowledge of the process did not extend beyond the use of certain brands or grades of pig iron, which, when annealed, would produce serviceable malleable castings. This book represents Mr. Moldenke's life work, and is devoted to clearing up the mysteries of the practice. It was with the hope that the work would serve to stimulate interest in this important industry that such a task was undertaken. The range of the book is best shown by citing the chapters: History, Early Development and Present Importance of the Malleable Iron Industry; Characteristics of Malleable Cast Iron; The Testing of Malleable Cast Iron; The Pattern Shop; Molding Methods in the Malleable Foundry; Melting Process; The Construction and Operation of the Air Furnace; Construction and Operation of the Open-Hearth Furnace; The Use of Gas Producers in Malleable Foundries; Mixing the Charges for Malleable Iron; Casting Malleable Iron; Annealing Malleable Castings; Characteristics of Malleable Fractures; Use of Pyrometer in Annealing Room; and Cost of Malleable Castings.

CATALOGUES AND CIRCULARS

SCHUCHARDT & SCHUTTE, Cedar and West Sts., New York. Leaflet describing indestructible "Elastric-grip" paper file-handles.

C. W. HUNT CO., West New Brighton, N. Y. Catalogue No. 114 describes the line of grab buckets, coal tubs and coal handling machinery, manufactured by this company.

HESS-BRIGHT MFG. CO., 2020 Fairmount Ave., Philadelphia, Pa. Folders announcing a new grease which this company has put on the market for use in anti-friction bearings.

BRISTOL CO., Waterbury, Conn. Bulletin 146A, Bristol Long-distance Recording Tachometer; and 147A Bristol-Durand Radii Averaging Instrument for Circular Chart Records.

THOS. H. DALLETT CO., Philadelphia, Pa. Bulletin No. 203 describes this company's duplex and compound belt-driven air compressors; bulletin No. 204 describes those that are steam-driven.

GENERAL ELECTRIC CO., Schenectady, N. Y. Bulletin No. 4821, Type F, K-12, Oil Break Switch; No. 4822, GE-98, Railway Motors; and No. 4823, Type F, Form K-10 and K-15, Oil Break Switches.

JOSEPH DIXON CRUCIBLE CO., Jersey City, N. J. Folder illustrating street railway properties painted with Dixon's silica-graphite paint. The folder explains the special adaptability of this paint for street railway uses.

MANVILLE BROS. CO., Waterbury, Conn. Catalogue of foot presses used by manufacturers of brass, steel and tin goods, celluloid work, for covering cloth buttons, securing trimmings to suspender webbing, eyeleting fabrics, etc.

CUSHMAN CHUCK CO., Hartford, Conn. The condensed 1911 catalogue and price list of Cushman chucks and faceplate jaws, containing the complete line manufactured by this firm in concise form. The variety shown is quite extensive.

MESTA MACHINE CO., Pittsburg, Pa. The Mesta horizontal double-acting four-cycle gas engine is the subject of an artistic booklet from this company, which describes the engine in a general way, and illustrates several typical installations.

MUMFORD MOLDING MACHINE CO., Plainfield, N. J., has just issued a loose-leaf catalogue illustrating its line of molding machines for foundry work, including jolt ramming machines, split pattern machines, power squeezers, and pneumatic vibrators.

FAIRBANKS, MORSE & CO., 900 South Wabash Ave., Chicago, Ill. Catalogue No. 76 on the "Eclipse" pumper, a vertical gasoline engine with jack suitable for pumping, running machinery, and other work on the farm requiring cheap and easily controlled power.

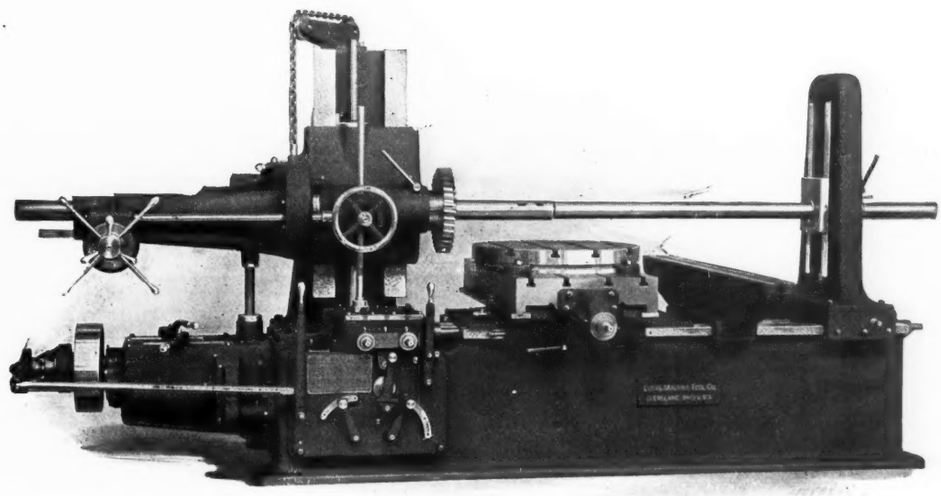
B. L. CO., Norwich, Conn., has recently issued a catalogue tabulating all the different sizes of B. L. radial bearings as applied to automobiles, this being the automobile edition. It is attractively gotten up and all information is contained in concise form for reference purposes.

We have found one case in which the CHEAPEST is the BEST.

The CHEAPEST and at the same time the BEST ADVERTISEMENT for us, is for YOU to come to our works and see for yourself HOW we make the

"PRECISION"

Boring, Drilling and Milling Machine



and WHY we make it as we do: we have a GOOD REASON for everything.

Lucas Machine Tool Co. Now and Always of **Cleveland, Ohio, U. S. A.**

AGENTS—C. W. Burton, Griffiths & Co., London. Alfred H. Schutte, Cologne, Brussels, Liege, Paris, Milan, Bilbao, Barcelona. Schuchardt & Schutte, Berlin, Stockholm, St. Petersburg, Copenhagen. Donauwerk Ernst Krause & Co., Vienna and Budapest. Overall, McCray, Ltd., Sydney, Australia. Andrews & George, Yokohama, Japan. Williams & Wilson, Montreal.

KEUFFEL & ESSER CO., Hoboken, N. J. Circular of the Champion continuous blueprinting machine which will blueprint tracings up to 54 inches wide, and of any length. The price of the machine complete with two mercury-vapor lamps is $850.

Q. M. S. Co., Plainfield, N. J., has issued attractive loose-leaf catalogues illustrating its line of metal sawing machines, hand-power traveling cranes, jib cranes, I-beam trolleys, pneumatic hoists, power hack-saws, car-wheel grinding machines, pneumatic pit jacks, etc.

VALLEY CITY MACHINE WORKS, Grand Rapids, Mich. Catalogue of emery grinding and polishing machinery, covering quite a wide range of sizes for different classes of work. But little descriptive matter is included, the main information given being the principal dimensions and other similar data.

THEO. ALTENEDER & SONS, Philadelphia, Pa. The latest catalogue of this company is a 100-page book describing the varied drawing instruments which it manufactures. Practically all instruments and appliances required by draftsmen are here listed and described in comprehensive manner.

CINCINNATI IRON & STEEL CO., Cincinnati, O. Ready reference book of classifications and lists of extra weights of "Cisco" iron and steel products. A wide range of iron and steel products is included in this book, which is one that should prove of especial value to every purchasing department.

BUFFALO FORGE CO., Buffalo, N. Y. Booklet No. 114 describes in detail a new type of strainer which this company is placing on the market for the removal of foreign matter from feed water, water supply, and similar systems. It differs from the usual types on the market, and is very simple in its construction.

DAVIS-BOURNONVILLE CO., 97 West St., New York. The second number of *Autogenous Welding* continues the interesting descriptions commenced in the first issue, showing several applications of autogenous welding to pipe lines as well as other places. Examples of welding heavy castings by this process form a feature of this issue.

FIRTH-STERLING STEEL CO., E. S. JACKMAN & Co., agents, 710-714 Lake St., Chicago, Ill., has recently published a little book on Blue Chip high-speed steel, setting forth the main features, and listing all the sizes, prices, etc., in a very convenient manner. The book is side indexed, being divided into ten divisions. The side-index feature makes it very useful.

EDGAR ALLEN AMERICAN MANGANESE STEEL CO., McCormick Bldg., Chicago, Ill. Pamphlet enumerating the uses of manganese steel castings manufactured by this company at Chicago Heights, Ill., and New Castle, Del. Examples of manganese steel parts used in the construction of many kinds of machinery, including mining, agricultural, dredging, railway, conveying, hoisting, brick machinery, etc., are given.

WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburg, Pa. Circular No. 1517 entitled "Railroad Electrification" describes several recent changes from steam to electrification on trunk roads, bearing more especially on the installations made by the company on the Pennsylvania and New York, New Haven & Hartford Railroads. Several foreign installations are also described and illustrated. The book is well gotten up.

EDGAR ALLEN AMERICAN MANGANESE STEEL CO., McCormick Bldg., Chicago, Ill. Pamphlet on manganese steel and its application to the ceramic industries, being a reprint of an address by Mr. G. W. Kneisly of the company before the twenty-fifth annual convention of the National Brick Manufacturers' Association at Louisville, Ky. The uses of manganese steel in brick making, rock crushing, cement machinery, etc., are briefly outlined.

LANDIS TOOL CO., Waynesboro, Pa., has issued an interesting and artistic booklet entitled, "A Trip Through the Plant of the Landis Tool Co.," in which the plant is illustrated and described from beginning to end. A few of the typical machines made by the company are shown in operation. The company has also issued a new booklet on the making and repairing of locomotives, in which the Landis grinder is shown in operation on different parts of the locomotive.

GEUDER, PAESCHKE & FREY CO., Milwaukee, Wis. Circular illustrating and describing a practical guard for punching, stamping, cutting, embossing and drawing presses and similar machines, consisting of a folding gate attached to the ram of the press in front, which protects the workman's hands during the down stroke. The device must be extended clear down to the bed of the press in front before the clutch can be engaged. No alteration of the press is required for this attachment.

AUTOMATIC TRANSPORTATION CO., 2933 Main St., Buffalo, N. Y. Catalogue of electric trucks, designed and constructed for handling package freight at railway and steamship terminals, freight houses, manufacturing plants, wholesale establishments, warehouses, storage plants, etc. The operation of the truck is simple; one charge of electricity will operate it for an entire day or night, at a small cost for power. The truck weighs 1800 pounds and will carry from 2000 to 4000 pounds of freight. The price for standard trucks is $1250; with double frame, $1300.

FRANK MOSSBERG CO., Attleboro, Mass., in its catalogue No. 101 describes the metal shears and spools which it manufactures. A wide variety is shown and described in this book. Other productions are also illustrated and described. There is also a circular of Mossberg double-end wrenches, hardened and tempered and furnished in three finishes, *viz*: semi-finished, finished, and polished nickel. An additional catalogue describes Mossberg socket wrenches as put up in sets in wooden or leather cases and separately to suit individual needs. A special catalogue is devoted to wrenches especially adapted for the use of automobile owners.

WESTMACOTT GAS FURNACE CO., 9 Codding St., Providence, R. I. Catalogue D of appliances using gas as fuel for the heat treatment of metals, comprising forges for treating high-speed and carbon steel for general shop use and special uses. These appliances are made in a variety of forms and sizes, including muffle furnaces for lead and cyanide hardening, chloride of potassium, brass melting, assaying and enamelling, brazing and soldering, etc., all of which are illustrated and described. Valuable data on heat treatment of high-speed steels, of various degrees of heat, etc., make the catalogue of unusual value to practical men.

PRATT & WHITNEY CO., Hartford, Conn., has just issued an extremely fine catalogue descriptive of its grinding machines. It is quite a large book, well printed and arranged in an attractive manner, representing a fine piece of typographical art. The first part of the book describes the different grinding machines made by the company, illustrating them fully with many of their more important attachments. The latter half of the book gives illustrations of the work which these machines will handle, and the pieces shown are remarkably varied in character, indicating the wide possibilities of the grinding machine. It is really a short descriptive treatise on the grinding machine.

TRADE NOTES

HILL-STANDARD MFG. CO., Anderson, Ind., has disposed of its tool department to the Union Caliper Co., Orange, Mass.

SMITH & WESSON, Springfield, Mass., will build a brick mill construction addition to their factory, 47 by 108 feet, which will cost $30,000.

OXY-ACETYLENE APPLIANCE CO., Singer Bldg., 149 Broadway, New York, is in the market for machinery and tools required for the manufacture of its apparatus. Catalogues are requested.

YALE & TOWNE MFG. CO., Stamford, Conn., is erecting a seven-story brass foundry. The plans and specifications are being prepared by Charles T. Main, mill engineer and architect of Boston, Mass.

NILES-BEMENT-POND CO., 111 Broadway, New York, has moved its warehouse from 30-31 West St., to Hudson and Van Dam Sts., New York. The removal affects particularly the large stock of Pratt & Whitney's small tools of all kinds which are sold at retail.

NEW HAVEN MACHINE SCREW CO., New Haven, Conn., manufacturer of screw machine products, which has been in existence four years as a partnership, was incorporated May 2. The officers are J. J. Reidy, president; Pierrepont B. Foster, treasurer; D. F. Reidy, secretary.

FOX TYPEWRITER CO., Grand Rapids, Mich., has for a number of years used a maltese cross with a fox head in the center for a trademark and same was recently registered. The company also uses a peculiar form in writing the word "Fox" and this also has been registered.

SPRAGUE ELECTRIC CO., announces the removal of its Boston office from the Weld Bldg. to 201 Devonshire St. More commodious quarters have been obtained in order that the increased demand for Sprague equipment may be more expeditiously handled throughout the New England territory.

UNIVERSAL VANADIUM CO., Frick Bldg., Pittsburg, Pa., is a corporation recently formed under the laws of the state of Delaware to act as selling agent for the American Vanadium Co. in conjunction with the Vanadium Sales Co. of America. The officers are Edward M. McIlvain, president; Colonel Millard Hunsiker, vice-president; and James C. Gray, secretary and treasurer.

CUMMINGS MACHINE CO., announces its removal to the Bush Terminal Bldg., Brooklyn, N. Y., where it now has enlarged space and increased equipment. The specialty of this company is the development and building of automatic machinery, but, in addition, it does experimental work, precision or model work, toolmaking, hardening, grinding, or anything in the machine shop line.

V. & O. PRESS CO., Glendale, N. Y., announces the establishment of a new Chicago agency where its product will be represented exclusively throughout that territory by Hill, Clarke & Co. Hill, Clarke & Co. will carry a full line of presses in stock and, in addition, will have a fully equipped demonstration shop where V. & O. presses, as well as other machinery, may be seen in operation.

L. S. STARRETT CO., Athol, Mass., is having plans and specifications prepared by Charles T. Main, mill engineer and architect of Boston, Mass., for a new office and graduating building. The construction will consist of outer walls of brick with reinforced concrete columns and steel framing protected by concrete. The main portion of the building will be 122 feet 10 inches long by 89 feet wide.

CRANE VALVE CO., Bridgeport, Conn., has let a contract to W. H. Boardman Co., New York City, for a heavy machine shop with traveling cranes, 50 feet by 353 feet. The Hooper-Faulkenau Engineering Co., 165 Broadway, New York City, acted as consulting engineers. The specifications were drawn and bids submitted and accepted in just two weeks from the day on which the engineers first took the work in hand.

NEW YORK LEATHER BELTING CO., 51 Beekman St., New York, announces that its new plant at Easton, Pa., for the manufacturing of Victor-Balata belting in America was opened for active operations May 1 under the name Victor-Balata & Textile Belting Co. The new company is composed of German and American interests that have been connected in a business way in the Balata belting line for a number of years.

NATIONAL TUBE CO., Pittsburg, Pa., recently took the members of the Pittsburg Railway Club and their friends on a trip which included a tour of the Ellwood City plant where the seamless tubing is made. Some four hundred participated in the excursion, and in the party were many prominent railway officials from various parts of the country. Incidentally, it might be mentioned that this plant is the largest seamless tube mill in the world.

NATIONAL-ACME MFG. CO., Cleveland, Ohio, announces the following changes in its sales department: A. W. Hokpins, purchasing agent and office manager, has been appointed sales manager of the product department; E. C. Woolgar, formerly western sales manager, has been appointed sales manager of the machinery department, with headquarters in Cleveland; and R. J. Preston succeeds E. C. Woolgar as manager of the western office and warehouse in Chicago.

DODGE MFG. CO., Mishawaka, Ind., recently furnished some heavy work for the Pittsburg Glass Co., Ford City, Pa., comprising a rope sheave in four sections, weighing 66,750 pounds, 8 feet diameter, and 16 feet 10 inches width of face. The sheave was mounted on a hollow shaft 24 inches in diameter with a 14-inch hole through its entire length of 28 feet 6 inches. The sheave carries 72 wraps of 2-inch rope, and is designed to transmit 4000 horsepower at 187 revolutions per minute.

FAY & SCOTT, Dexter, Me., manufacturers of engine lathes and patternmaker's lathes are building an addition to their plant which will increase the floor space 11,000 square feet. The building comprises an addition to the planing and milling departments, consisting of a single-story concrete structure, 40 by 50 feet; also a two-story building, concrete construction, 40 by 90 feet, to be used largely for storeroom and stock-room. The plans and contracts have been made and the work is in progress. No new machine equipment will be required.

NATIONAL-ACME MFG. CO., Cleveland, Ohio, announces that the suit brought by it against the Universal Machine Screw Co., Hartford, Conn., has been settled out of court on the payment of royalties for past infringement and the expenses of the action, by the defendant. A non-exclusive license has been issued by the Universal Machine Screw Co., under which it may continue to build, use and sell multiple-spindle screw machines embodying the subject matter of the letters patent which have been infringed, in consideration of payment to the National-Acme Mfg. Co. of a royalty on all machines so built.

NEW BRITAIN MACHINE CO., New Britain, Conn., manufacturer of a line of wood-working machinery, grinding machinery and shop furniture, has bought the business of George G. Prentice & Co., New Haven, Conn., manufacturers of multiple-spindle automatic turret machines. Mr. Prentice, who for the past ten years has devoted himself to the manufacture and development of the lathe, retires from business on account of ill health. The New Britain Machine Co. will move the Prentice plant to New Britain, and will immediately erect an addition, 56 by 150 feet, making a main machine shop and floor served by a traveling crane 400 feet long.

NATIONAL BRAKE & CLUTCH CO., 16 State St., Boston, Mass., has changed its firm name to the Cork Insert Co. The company which was originally interested in the manufacture and use in automobiles and street cars of cork insert clutches and brakes, has so broadened the scope of its business among almost every class of power user, by the introduction of cork inserts in many types of pulleys, clutches, brakes, frictions, tensions, etc., that it has been deemed expedient to change the name of the corporation to one more indicative of the business as at present conducted.